

## **Appendix I**

**This section contains the data that support the information provided  
in Table 7 as well as Sections 4 and 5 of this report.**

**TABLE 8 VOC 5-point Calibration Linear Regression Analysis and Average RF**

Calibration Date: 8/21/1996

Compound	IFD Algorithm			EnviroQuant Software		
	(Slope ± Std.Dev.) x 103	(Intercept ± Error) x 101	RFcal ± %RSD	RFcal ± %RSD	(Slope ± Std.Dev.) x 103	(Intercept ± Error) x 101
1,1,1-Trichloroethane	11.3 ± 0.3	-2.41 ± 1.43	1.01 ± 8	1.05 ± 8	11.2 ± 0.3	-1.89 ± 1.28
1,1,-Dichloroethane	8.38 ± 0.31	-2.08 ± 1.29	0.73 ± 11	0.76 ± 9	8.27 ± 0.28	-1.72 ± 1.20
1,1-Dichloroethene	1.87 ± 0.03	-0.326 ± 0.120	0.17 ± 12	0.18 ± 5	1.86 ± 0.03	-0.26 ± 0.15
1,2-Dichloroethane	4.40 ± 0.14	-0.475 ± 0.580	0.43 ± 24	0.45 ± 27	4.21 ± 0.11	-0.06 ± 0.48
Benzene	24.9 ± 1.3	-10.1 ± 4.8	1.93 ± 16	1.99 ± 15	24.6 ± 1.2	-9.29 ± 4.72
Carbon Tetrachloride	13.7 ± 0.6	-4.91 ± 2.32	1.11 ± 13	1.12 ± 13	13.5 ± 0.6	-4.65 ± 2.30
Chlorobenzene	15.9 ± 0.7	-3.77 ± 2.98	1.41 ± 14	1.45 ± 15	15.7 ± 0.7	-3.27 ± 2.83
Chloroform	12.0 ± 0.4	-1.59 ± 1.49	1.16 ± 12	1.16 ± 12	11.9 ± 0.3	-1.43 ± 1.35
cis-1,2-dichloroethene	4.90 ± 0.19	-1.02 ± 0.80	0.46 ± 14	0.46 ± 13	4.87 ± 0.18	-0.955 ± 0.766
Ethylbenzene	20.8 ± 1.3	-8.29 ± 5.37	1.71 ± 18	1.70 ± 17	20.7 ± 1.2	-8.04 ± 5.14
m/p-Xylene	18.3 ± 1.2	-17.4 ± 10.1	1.42 ± 18	1.41 ± 18	18.0 ± 1.2	-16.8 ± 9.7
o-Xylene	20.3 ± 1.4	-12.4 ± 6.4	1.53 ± 22	1.53 ± 21	20.1 ± 1.4	-12.0 ± 6.1
Styrene	18.6 ± 1.3	-8.80 ± 5.66	1.49 ± 20	1.49 ± 19	18.4 ± 1.2	-8.44 ± 5.45
Tetrachloroethene	9.15 ± 0.37	-1.46 ± 1.55	0.86 ± 10	0.88 ± 13	9.07 ± 0.36	-1.24 ± 1.51
Toluene	16.9 ± 1.0	-9.00 ± 4.32	1.31 ± 20	1.40 ± 13	16.3 ± 0.8	-5.28 ± 3.49
trans-1,2-dichloroethene	2.30 ± 0.05	-0.176 ± 0.220	0.22 ± 6	0.22 ± 5	2.29 ± 0.06	-0.194 ± 0.245
Trichloroethene	6.56 ± 0.26	-1.33 ± 1.10	0.59 ± 9	0.61 ± 12	6.49 ± 0.26	-1.07 ± 1.07
Vinyl Chloride	0.812 ± 0.226	-0.492 ± 1.090	0.09 ± 29	0.10 ± 19	0.679 ± 0.233	1.51 ± 1.21
<b>Summary:</b>						
≤ 30%			18	18		
≤ 40%			0	0		
> 40%			0	0		

**TABLE 8 continued. VOC 5-point Calibration Linear Regression Analysis and Average RF****Calibration Date: 8/26/1996**

<b>Compound</b>	<b>(Slope ± Std.Dev.) x 10<sup>3</sup></b>	<b>(Intercept ± Error) x 10<sup>1</sup></b>	<b>RFcal ± %RSD</b>
1,1,1-Trichloroethane	19.3 ± 1.2	-5.23 ± 4.97	1.73 ± 11
1,1,-Dichloroethane	15.4 ± 0.9	-3.87 ± 3.61	1.40 ± 13
1,1-Dichloroethene	2.74 ± 0.15	-0.630 ± 0.637	0.26 ± 22
1,2-Dichloroethane	8.22 ± 0.60	-1.39 ± 2.47	0.81 ± 21
Benzene	19.5 ± 5.6	25.6 ± 26.0	2.59 ± 24
Carbon Tetrachloride	10.2 ± 1.8	6.11 ± 8.92	1.15 ± 25
Chlorobenzene	20.9 ± 1.2	-5.28 ± 4.10	1.78 ± 12
Chloroform	23.9 ± 1.8	-7.88 ± 7.73	2.14 ± 13
cis-1,2-dichloroethene	8.64 ± 0.53	-1.78 ± 2.20	0.82 ± 13
Ethylbenzene	25.6 ± 1.5	-7.57 ± 5.08	2.10 ± 15
m/p-Xylene	22.0 ± 1.5	-15.3 ± 10.3	1.74 ± 17
o-Xylene	27.3 ± 2.4	-11.0 ± 7.9	1.96 ± 24
Styrene	31.3 ± 2.2	-18.5 ± 9.1	2.18 ± 25
Tetrachloroethene	8.03 ± 0.35	-2.12 ± 1.45	0.71 ± 11
Toluene	18.2 ± 0.9	-5.13 ± 3.15	1.48 ± 15
trans-1,2-dichloroethene	3.05 ± 0.16	-0.360 ± 0.655	0.30 ± 15
Trichloroethene	7.23 ± 0.30	-2.24 ± 1.24	0.60 ± 13
Vinyl Chloride	0.624 ± 0.093	-0.750 ± 0.448	0.03 ± 59
<b>Summary:</b>			
≤ 30%			17
≤ 40%			0
> 40%			1

**TABLE 8 continued. VOC 5-point Calibration Linear Regression Analysis and Average RF**

Calibration Date: 8/29/1996

<b>Compound</b>	<b>(Slope ± Std.Dev.) x 103</b>	<b>(Intercept ± Error) x 101</b>	<b>RFcal ± %RSD</b>
1,1,1-Trichloroethane	12.8 ± 0.3	-2.61 ± 0.94	1.03 ± 12
1,1,-Dichloroethane	10.5 ± 0.3	-2.20 ± 1.00	0.85 ± 12
1,1-Dichloroethene	9.93 ± 0.31	-2.30 ± 1.01	0.78 ± 12
1,2-Dichloroethane	4.20 ± 0.04	-0.225 ± 0.144	0.40 ± 8
Benzene	38.5 ± 2.1	-15.6 ± 6.9	2.42 ± 27
Carbon Tetrachloride	15.4 ± 0.7	-2.89 ± 1.17	1.18 ± 14
Chlorobenzene	15.4 ± 0.7	-5.84 ± 2.30	0.99 ± 26
Chloroform	11.5 ± 0.2	-1.80 ± 0.76	0.98 ± 9
cis-1,2-dichloroethene	7.80 ± 0.22	-1.56 ± 0.72	0.64 ± 11
Ethylbenzene	19.0 ± 1.2	-5.00 ± 2.14	1.28 ± 21
m/p-Xylene	17.5 ± 1.3	-13.2 ± 5.1	1.08 ± 27
o-Xylene	16.7 ± 1.2	-6.18 ± 2.30	1.03 ± 27
Styrene	14.4 ± 0.9	-4.10 ± 1.54	0.92 ± 25
Tetrachloroethene	12.4 ± 0.6	-2.58 ± 1.02	0.91 ± 16
Toluene	15.9 ± 0.8	-5.06 ± 1.55	1.06 ± 23
trans-1,2-dichloroethene	9.40 ± 0.33	-2.13 ± 1.09	0.76 ± 11
Trichloroethene	9.20 ± 0.29	-2.56 ± 0.94	0.64 ± 25
Vinyl Chloride	16.9 ± 0.9	-4.03 ± 1.52	1.15 ± 25
<b>Summary:</b>			
≤ 30%			18
≤ 40%			0
> 40%			0

**TABLE 9. VOC Comparison of Initial and Continuing Calibration RF Values**

Calib. Date: 8/21/96

CCV Date:	8/21/96		08/22/96		08/22/96		08/23/96		08/24/96	
	IFD	ENVQ								
Compound	RF (%Diff.)									
1,1,1-Trichloroethane	1.24 (23)	1.27 (26)	1.22 (21)	1.25 (24)	1.29 (28)	1.32 (31)	1.14 (13)	1.18 (16)	1.15 (15)	1.27 (26)
1,1-Dichloroethane	0.97 (33)	0.98 (34)	0.93 (27)	0.95 (30)	0.96 (32)	0.98 (34)	0.89 (22)	0.90 (23)	1.00 (37)	1.00 (38)
1,1-Dichloroethene	0.21 (29)	0.21 (24)	0.21 (27)	0.21 (24)	0.20 (22)	0.21 (24)	0.19 (17)	0.20 (16)	0.19 (18)	0.20 (17)
1,2-Dichloroethane	0.54 (25)	0.54 (26)	0.54 (25)	0.54 (26)	0.51 (17)	0.51 (19)	0.48 (10)	0.47 (10)	0.55 (27)	0.52 (21)
Benzene	2.52 (30)	2.53 (31)	2.42 (25)	2.43 (26)	2.37 (23)	2.38 (23)	2.22 (15)	2.24 (16)	2.39 (24)	2.38 (23)
Carbon Tetrachloride	1.37 (24)	1.38 (24)	1.28 (16)	1.30 (17)	1.24 (12)	1.24 (12)	1.17 (6)	1.18 (6)	1.24 (12)	1.24 (12)
Chlorobenzene	1.49 (5)	1.51 (7)	1.53 (8)	1.54 (9)	1.38 (3)	1.38 (2)	1.58 (12)	1.61 (14)	1.58 (12)	1.58 (12)
Chloroform	1.32 (14)	1.43 (23)	1.35 (16)	1.46 (26)	1.36 (18)	1.49 (28)	1.20 (4)	1.32 (14)	1.02 (12)	1.47 (27)
cis-1,2-Dichloroethene	0.56 (23)	0.57 (24)	0.54 (18)	0.54 (17)	0.57 (24)	0.57 (24)	0.51 (12)	0.52 (12)	0.54 (19)	0.56 (22)
Ethylbenzene	1.87 (9)	1.88 (10)	1.88 (10)	1.88 (10)	1.65 (3)	1.66 (3)	1.97 (15)	1.99 (16)	2.02 (18)	2.02 (18)
m/p-Xylene	1.58 (11)	1.58 (11)	1.57 (11)	1.57 (11)	1.33 (6)	1.33 (6)	1.60 (13)	1.61 (14)	1.71 (21)	1.70 (20)
o-Xylene	1.81 (19)	1.83 (20)	1.76 (15)	1.76 (15)	1.32 (13)	1.30 (15)	1.80 (18)	1.78 (17)	2.01 (32)	1.99 (30)
Styrene	1.74 (17)	1.75 (17)	1.72 (15)	1.73 (16)	1.29 (14)	1.29 (13)	1.77 (19)	1.79 (20)	1.91 (28)	1.91 (28)
Tetracholoroethene	0.87 (2)	0.88 (2)	0.81 (5)	0.82 (5)	0.81 (6)	0.81 (6)	0.87 (2)	0.88 (2)	0.85 (0)	0.85 (1)
Toluene	1.43 (9)	1.45 (11)	1.44 (10)	1.47 (12)	1.46 (11)	1.47 (12)	1.61 (23)	1.62 (24)	1.50 (14)	1.50 (15)
trans-1,2-Dichloroethene	0.27 (21)	0.27 (23)	0.25 (14)	0.25 (14)	0.27 (23)	0.27 (23)	0.22 (2)	0.23 (3)	0.22 (1)	0.23 (4)
Trichloroethene	0.61 (4)	0.61 (3)	0.65 (12)	0.66 (12)	0.64 (9)	0.65 (10)	0.64 (9)	0.65 (10)	0.59 (1)	0.59 (1)
Vinyl Chloride	0.05 (31)	0.06 (33)	0.11 (55)	0.11 (22)	0.02 (73)	0.02 (78)	0.09 (30)	0.10 (8)	0.04 (41)	0.06 (34)
<b>Summary :</b>										
≤ 30%	18	17	19	20	18	17	20	20	17	18
≤ 40%	2	3	0	0	1	2	0	0	2	2
> 40%	0	0	1	0	1	1	0	0	1	0

**TABLE 9 continued. VOC Comparison of Initial and Continuing Calibration RF Values**

Calibration Date: 8/26/96				Calibration Date: 8/29/96	
CCV Date: Compound	8/27/96 RF (%Diff.)	08/28/96 RF (%Diff.)	8/28/96 RF (%Diff.)	8/29/96 RF (%Diff.)	8/30/96 RF (%Diff.)
1,1,1-Trichloroethane	1.41 (19)	1.74 (0)	1.72 (1)	0.98 (4)	1.36 (32)
1,1-Dichloroethane	1.19 (15)	1.40 (0)	1.66 (18)	0.84 (1)	1.01 (19)
1,1-Dichloroethene	0.20 (23)	0.22 (15)	0.25 (6)	0.80 (2)	0.94 (21)
1,2-Dichloroethane	0.57 (29)	0.73 (10)	0.89 (9)	0.40 (0)	0.50 (23)
Benzene	2.67 (3)	3.06 (18)	3.41 (31)	2.53 (5)	3.13 (29)
Carbon Tetrachloride	1.36 (18)	1.57 (36)	1.56 (36)	1.37 (15)	1.52 (28)
Chlorobenzene	1.93 (8)	2.10 (18)	2.18 (22)	1.12 (14)	1.19 (21)
Chloroform	1.77 (17)	2.04 (5)	2.32 (9)	0.99 (1)	1.22 (24)
cis-1,2-Dichloroethene	0.61 (25)	0.82 (1)	0.89 (9)	0.62 (3)	0.77 (19)
Ethylbenzene	2.41 (15)	2.84 (35)	2.82 (35)	1.67 (30)	1.79 (39)
m/p-Xylene	2.02 (16)	2.26 (29)	2.35 (35)	1.46 (36)	1.49 (38)
o-Xylene	2.30 (17)	2.70 (38)	2.53 (29)	1.41 (37)	1.28 (23)
Styrene	2.18 (0)	2.59 (19)	2.77 (27)	1.28 (38)	1.27 (38)
Tetracholoroethene	0.78 (10)	0.95 (33)	0.87 (22)	1.16 (28)	1.17 (29)
Toluene	1.77 (20)	1.97 (33)	1.86 (25)	1.41 (33)	1.47 (39)
trans-1,2-Dichloroethene	0.25 (18)	0.24 (20)	0.27 (9)	0.75 (2)	0.95 (24)
Trichloroethene	0.69 (15)	0.74 (23)	1.32 (118)	0.69 (7)	0.76 (18)
Vinyl Chloride	0.02 (43)	0.05 (49)	0.08 (120)	1.46 (27)	1.10 (4)
<b>Summary :</b>					
≤ 30%	17	12	12	14	13
≤ 40%	0	5	4	4	5
> 40%	1	1	2	0	0

**TABLE 10. SVOC 5-point Calibration Linear Regression Analysis and Average RF**  
**Calibration Date: 9/4/1996**

Compound	IFD Algorithm			EnviroQuant Software		
	(Slope ± Std.Dev.) x 10 <sup>3</sup>	(Intercept ± Error) x 10 <sup>1</sup>	RFcal ± %RSD	RFcal ± %RSD	(Slope ± Std.Dev.) x 10 <sup>3</sup>	(Intercept ± Error) x 10 <sup>1</sup>
Acenaphthene	4.16 ± 0.18	-0.537 ± 0.385	0.84 ± 14	0.84 ± 15	4.21 ± 0.18	-0.551 ± 0.387
Acenaphthylene	7.68 ± 0.53	-1.39 ± 1.15	1.55 ± 24	1.39 ± 22	7.81 ± 0.53	-1.50 ± 1.15
Anthracene/Phenanthrene	3.36 ± 0.13	-0.347 ± 0.549	0.81 ± 9	1.79 ± 27	5.58 ± 0.13	0.954 ± 0.577
Benzo(a)pyrene	6.01 ± 0.00	-0.654 ± 0.271	1.31 ± 11	1.36 ± 11	6.05 ± 0.13	-0.641 ± 0.326
Benzo(g,h,I)perylene	5.38 ± 0.23	-0.630 ± 0.502	1.14 ± 16	1.18 ± 19	5.41 ± 0.24	-0.623 ± 0.523
Benzo[a]anthracene/Chrysene	5.14 ± 0.05	-0.471 ± 0.200	1.55 ± 21	1.57 ± 18	5.20 ± 0.05	0.613 ± 0.197
Benzo[b]/(k)fluoranthene	11.6 ± 0.1	-0.053 ± 0.282	2.83 ± 10	1.41 ± 10	11.8 ± 0.1	-0.102 ± 0.263
Dibenz(a,h)anthracene	2.50 ± 0.57	1.16 ± 1.24	1.03 ± 27	1.17 ± 18	5.48 ± 0.15	-0.520 ± 0.335
Fluoranthene	5.77 ± 0.14	0.566 ± 0.304	1.94 ± 31	2.01 ± 40	5.83 ± 0.13	0.538 ± 0.276
Fluorene	4.24 ± 0.09	-0.102 ± 0.197	1.05 ± 9	1.03 ± 6	4.30 ± 0.08	-0.120 ± 0.182
Indeno(1,2,3-c,d)pyrene	3.56 ± 0.44	0.761 ± 0.948	1.18 ± 22	1.41 ± 19	6.63 ± 0.28	-0.788 ± 0.597
Naphthalene	2.63 ± 0.33	-0.194 ± 0.377	0.53 ± 37	0.58 ± 65	2.69 ± 0.32	-0.242 ± 0.366
Pyrene	6.04 ± 0.09	0.701 ± 0.207	1.89 ± 21	1.85 ± 19	6.00 ± 0.09	0.668 ± 0.217
Cl-1	1.65 ± 0.20	-0.063 ± 0.069	0.32 ± 30	0.39 ± 32	2.15 ± 0.13	-0.072 ± 0.046
Cl-2	1.88 ± 0.15	-0.037 ± 0.055	0.47 ± 27	0.37 ± 16	1.63 ± 0.11	-0.042 ± 0.040
Cl-3	1.49 ± 0.10	0.111 ± 0.036	0.58 ± 36	0.33 ± 12	1.30 ± 0.06	-0.013 ± 0.021
Cl-4	0.946 ± 0.033	-0.043 ± 0.025	0.20 ± 15	0.20 ± 10	0.845 ± 0.009	-0.019 ± 0.008
Cl-5	0.798 ± 0.018	-0.025 ± 0.013	0.17 ± 13	0.18 ± 11	0.695 ± 0.005	-0.004 ± 0.004
Cl-6	0.745 ± 0.012	-0.003 ± 0.014	0.17 ± 18	0.17 ± 8	0.644 ± 0.007	0.002 ± 0.006
Cl-7	0.659 ± 0.026	0.002 ± 0.028	0.16 ± 12	0.17 ± 8	0.608 ± 0.017	0.019 ± 0.018
Cl-8	0.338 ± 0.003	-0.012 ± 0.003	0.07 ± 16	0.07 ± 8	0.294 ± 0.005	-0.001 ± 0.005
Cl-10	0.352 ± 0.008	-0.037 ± 0.015	0.07 ± 21	0.06 ± 19	0.304 ± 0.008	-0.024 ± 0.014
<b>Summary:</b>			19	19		
≤ 30%			3	2		
≤ 40%			0	1		
> 40%						

**TABLE 10 continued. SVOC 5-point Calibration Linear Regression Analysis and Average RF**  
**Calibration Date: 9/17/1996**

<b>Compound</b>	<b>(Slope ± Std.Dev.) x 103</b>	<b>(Intercept ± Error) x 102</b>	<b>RFcal ± %RSD</b>
Acenaphthene	2.04 ± 0.19	-2.29 ± 3.18	0.45 ± 26
Acenaphthylene	4.14 ± 0.16	-1.09 ± 2.59	1.03 ± 12
Anthracene/Phenanthrene	8.04 ± 0.39	-10.9 ± 6.6	1.64 ± 18
Benzo(a)pyrene	1.41 ± 0.09	-0.406 ± 1.760	0.32 ± 26
Benzo(g,h,I)perylene	0.840 ± 0.057	0.200 ± 1.170	0.20 ± 25
Benzo[a]anthracene/Chrysene	3.29 ± 0.10	-9.35 ± 3.54	0.60 ± 28
Benzo[b]/(k)fluoranthene	1.92 ± 0.12	0.119 ± 4.520	0.45 ± 27
Dibenz(a,h)anthracene	1.23 ± 0.04	0.400 ± 0.696	0.31 ± 22
Fluoranthene	2.74 ± 0.11	-1.73 ± 1.06	0.59 ± 14
Fluorene	2.92 ± 0.14	-4.64 ± 2.44	0.55 ± 25
Indeno(1,2,3-c,d)pyrene	1.31 ± 0.06	0.426 ± 1.300	0.30 ± 30
Naphthalene	2.95 ± 0.12	-2.62 ± 2.27	0.66 ± 8
Pyrene	5.32 ± 0.26	-11.0 ± 4.9	0.93 ± 23
Cl-1	2.44 ± 0.16	-0.055 ± 0.267	0.59 ± 26
Cl-2	1.95 ± 0.18	-0.857 ± 0.689	0.34 ± 31
Cl-3	1.18 ± 0.06	-0.382 ± 0.195	0.21 ± 23
Cl-4	0.640 ± 0.035	-0.331 ± 0.125	0.11 ± 36
Cl-5	0.821 ± 0.100	-1.39 ± 0.77	0.12 ± 39
Cl-6	0.765 ± 0.088	-1.12 ± 0.76	0.12 ± 36
Cl-7	0.577 ± 0.034	-0.562 ± 0.173	0.08 ± 36
Cl-8	0.335 ± 0.020	-0.251 ± 0.118	0.06 ± 34
Cl-10	0.240 ± 0.013	-0.226 ± 0.254	0.05 ± 34
<b>Summary:</b>			
≤ 30%			15
≤ 40%			7
> 40%			0

**TABLE 11. SVOC Comparison of Initial and Continuing Calibration RF Values**

**Calibration Date: 9/4/96**

CCV Date:	9/4/96		9/5/96		9/5/96	
	IFD	ENV	IFD	ENV	IFD	ENV
Compound	RF (%Diff.)					
Acenaphthene	0.91 (9)	0.92 (10)	1.01 (20)	1.02 (22)	0.74 (12)	0.59 (29)
Acenaphthalene	1.45 (6)	1.47 (6)	1.62 (5)	1.64 (18)	1.02 (34)	1.20 (14)
Phenanthrene/Anthracene	1.58 (2)	1.59 (11)	1.71 (6)	1.72 (4)	1.28 (58)	1.83 (2)
Benzo[a]pyrene	1.38 (5)	1.38 (1)	1.18 (9)	1.23 (10)	1.05 (20)	0.84 (38)
Benzo[g,h,I]perylene	0.87 (24)	0.87 (26)	0.91 (20)	0.91 (23)	0.33 (71)	0.26 (78)
Benzo[a]anthracene/Chrysene	1.46 (6)	1.47 (6)	1.42 (8)	1.43 (9)	1.95 (26)	1.55 (1)
Benzo[b]/(k)fluoranthene	1.48 (5)	1.49 (6)	1.1 (22)	1.38 (2)	1.14 (20)	0.91 (35)
Dibenz(a,h)anthracene	1.00 (3)	1.01 (14)	1.01 (2)	1.02 (13)	0.56 (46)	0.44 (62)
Fluoranthene	1.59 (18)	1.59 (21)	1.81 (7)	1.82 (9)	2.12 (9)	1.7 (15)
Fluorene	1.08 (3)	1.09 (6)	1.19 (14)	1.21 (17)	1.17 (12)	0.94 (9)
Indeno(1,2,3-c,d)pyrene	0.98 (17)	1.08 (23)	0.92 (22)	1.14 (19)	0.48 (59)	0.38 (73)
Naphthalene	1.31 (148)	1.11 (91)	0.68 (29)	0.58 (0)	0.37 (30)	0.30 (48)
Pyrene	1.95 (3)	1.94 (5)	1.74 (8)	1.73 (6)	2.50 (32)	2.07 (12)
Cl-1	0.36 (12)	0.49 (26)	0.38 (19)	0.55 (41)	0.35 (9)	0.36 (7)
Cl-2	0.33 (29)	0.32 (12)	0.35 (27)	0.36 (1)	0.26 (45)	0.23 (37)
Cl-3	0.27 (33)	0.24 (26)	0.29 (28)	0.25 (23)	0.26 (36)	0.18 (45)
Cl-4	0.17 (16)	0.18 (11)	0.17 (15)	0.18 (11)	0.16 (21)	0.17 (16)
Cl-5	0.16 (7)	0.16 (10)	0.14 (18)	0.14 (21)	0.12 (28)	0.12 (32)
Cl-6	0.13 (25)	0.15 (10)	0.22 (31)	0.14 (16)	0.13 (22)	0.12 (28)
Cl-7	0.19 (21)	0.16 (5)	0.13 (18)	0.14 (17)	0.15 (5)	0.16 (5)
Cl-8	0.08 (10)	0.07 (5)	0.06 (12)	0.06 (19)	0.05 (23)	0.06 (19)
Cl-10	0.08 (29)	0.08 (27)	0.06 (8)	0.06 (5)	0.04 (40)	0.03 (52)
<b>Summary :</b>						
≤ 30%	20	21	21	21	13	12
≤ 40%	1	0	1	0	4	4
> 40%	1	1	0	1	5	6

**TABLE 11 continued. SVOC Comparison of Initial and Continuing Calibration RF Values****Calibration Date: 9/16/96**

<b>CCV Date:</b> <b>Compound</b>	<b>9/16/96</b> <b>RF (%Diff.)</b>	<b>9/17/96</b> <b>RF (%Diff.)</b>	<b>9/17/96</b> <b>RF (%Diff.)</b>
Acenaphthene	0.41 (9)	0.42 (6)	0.60 (35)
Acenaphthalene	0.69 (33)	0.77 (25)	1.15 (13)
Phenanthrene/Anthracene	0.74 (10)	0.70 (15)	1.13 (37)
Benzo[a]pyrene	0.35 (10)	0.38 (18)	0.24 (26)
Benzo[g,h,I]perylene	0.21 (4)	0.25 (23)	0.14 (30)
Benzo[a]anthracene/Chrysene	0.53 (11)	0.69 (16)	0.59 (1)
Benzo[b]/(k)fluoranthene	0.45 (0)	0.57 (27)	0.29 (34)
Dibenz(a,h)anthracene	0.29 (7)	0.33 (7)	0.21 (30)
Fluoranthene	0.48 (18)	0.66 (12)	0.97 (64)
Fluorene	0.45 (18)	0.49 (9)	0.79 (45)
Indeno(1,2,3-c,d)pyrene	0.31 (4)	0.37 (25)	0.33 (11)
Naphthalene	0.36 (46)	0.67 (1)	0.64 (3)
Pyrene	0.87 (6)	0.83 (11)	1.30 (40)
Cl-1	0.50 (16)	0.48 (19)	0.54 (8)
Cl-2	0.32 (6)	0.27 (21)	0.27 (20)
Cl-3	0.23 (8)	0.23 (7)	0.27 (25)
Cl-4	0.11 (3)	0.11 (5)	0.14 (34)
Cl-5	0.09 (27)	0.08 (35)	0.13 (11)
Cl-6	0.08 (36)	0.07 (44)	0.09 (24)
Cl-7	0.08 (9)	0.10 (17)	0.10 (18)
Cl-8	0.05 (17)	0.05 (6)	0.06 (0)
Cl-10	0.05 (5)	0.06 (26)	0.03 (45)
<b>Summary :</b>			
≤ 30%	19	20	14
≤ 40%	2	1	5
> 40%	1	1	3

**TABLE 12 VOC Purge and Trap GC/MS MDL Study, 20ppb Measured**

Repetitions Compounds	n=1	2	3	4	5	6	7	Conc. Average ppb	STDEV	%RSD	MDL ppb	1/2 20DAF (QL) ppb	RL ppb
1,1,1-Trichloroethane	17.2	13.0	15.3	21.5	15.5	18.2	15.6	16.6	2.70	16	8	1000	20
1,1-Dichloroethane	19.6	18.8	18.2	22.1	16.4	20.2	21.4	19.5	1.94	10	6	10	20
1,1-Dichloroethene	23.5	20.1	20.5	21.3	21.0	21.3	20.9	21.2	1.10	5	3	30	20
1,2-Dichloroethane	19.7	13.8	21.0	27.2	20.8	15.9	18.9	19.6	4.26	22	13	10	20
Benzene	17.8	16.9	18.5	19.7	18.0	16.4	17.3	17.8	1.09	6	3	15	20
Carbon Tetrachloride	22.3	19.3	20.0	20.1	19.1	19.7	18.2	19.8	1.27	6	4	35	20
Chlorobenzene	9.8	13.5	14.7	18.5	12.6	15.8	13.9	14.1	2.70	19	8	500	20
Chloroform	22.8	22.1	24.1	24.7	18.7	23.3	26.8	23.2	2.50	11	8	300	20
cis-1,2-Dichloroethene	20.4	19.4	23.6	22.8	19.6	19.4	22.1	21.1	1.74	8	5	200	20
Ethylbenzene	17.7	19.3	15.3	18.8	16.5	21.1	18.0	18.1	1.90	10	6	6500	20
m/p-Xylene	69.9	69.3	61.4	70.1	60.5	74.9	64.8	67.3	5.22	8	16	105000	80
Methylene Chloride	112.4	93.1	91.2	102.2	92.6	100.8	101.1	99.1	7.47	8	23	10	20
o-Xylene	20.2	21.0	20.3	20.7	19.2	21.0	18.7	20.1	0.91	4	3	95000	20
Styrene	17.0	13.8	12.0	14.7	15.6	15.9	17.2	15.2	1.82	12	6	2000	20
Tetracholoroethene	20.0	21.4	17.3	20.8	16.8	20.1	18.2	19.2	1.77	9	6	30	20
Toluene	9.6	16.2	16.6	13.7	13.8	19.6	13.8	14.7	3.11	21	10	6000	40
trans-1,2-Dichloroethene	21.3	19.2	22.1	25.9	23.2	21.9	22.1	22.2	2.03	9	6	300	20
Trichloroethene	15.6	30.1	14.3	19.7	11.9	18.3	18.3	18.3	5.84	32	18	30	20
Vinyl Chloride	33.7	29.1	22.9	53.9	25.1	29.0	26.9	31.5	10.45	33	33	5	20

#### Notes

- MDL was calculated based on seven repetitions of the lowest concentration point on the calibration curve
- MDL was calculated using 3.14 times the Std. Deviation
- Project RL shown as lowest calibration standard

**TABLE 13 PAH and PCB TD GC/MS MDL Study**

Repetitions Compound	n=1	2	3	4	5	6	7	Average Area	STDEV	% RSD	MDL ppb	1/2 20DAF (QL) ppb
Acenaphthene	6649403	7851807	8191401	7377699	8438145	7063528	6058243	7375747	854546	12	87	285
Acenaphthylene	14563063	17842996	17246170	16310802	15325549	11898542	12502504	15098518	2270521	15	113	285
Benzo(a)pyrene	8413426	9666725	6531195	8494624	7549711	9732398	9077397	8495068	1154703	14	102	4
Benzo(g,h,i)perylene	5142449	9884367	10925683	6537324	8415502	7071490	8446701	8060502	1984279	25	186	NA
Benzo[a]anthracene /Chrysene	20432464	25734266	23100056	21369574	15665514	25460688	23522470	22183576	3468755	16	236	1
Benzo[b]/(k)fluoranthene	19447460	22131472	18448872	17972126	15064513	22207020	20813890	19440765	2551794	13	297	2.5
Dibenz(a,h)anthracene	6100368	9427042	5158919	7058936	8385818	7205351	8998377	7476401	1552438	21	156	1
Fluoranthene	10345314	12216560	11324217	14004980	10300769	14506519	10800127	11928355	1724108	14	109	2150
Fluorene	5924988	8511248	8256192	11185856	7468333	7163530	7861336	8053069	1620917	20	152	280
Indeno(1,2,3-c,d)pyrene	6130939	10688591	5935142	7760468	9561425	7682154	10045352	8257724	1884167	23	172	7
Naphthalene	7283304	6927502	6000463	3327857	7377352	1434547	2601105	4993161	2478049	50	374	42
Phenanthrene /Anthracene	23240630	36364432	29846948	32649398	30643870	30505696	31870770	30731678	3950958	13	194	280
Pyrene	10468125	15433087	13827595	14585089	8808344	13354526	13720097	12885266	2368184	18	139	2100
Total PCB	31782678	53055163	45648091	35342905	30341274	41428176	43905398	40214812	9705925	20	153	0.5

**Notes**

- MDL was run prior to the initial calibration and calculated based on seven repetitions of a fortified soil sample containing 300-ppb total PCB and 300-ppb each PAH
- 40uL injected, normally inject 50 uL (4/5 coefficient used when MDL calculated)
- MDL was calculated using 3.14 times the product of the %RSD and the concentration injected

**Table 14. VOC Measurement Precision**

Sample ID: S1-B1A-(02-04)

<u>Compounds</u>	<u>MDL</u>	<u>8/26/96</u>	<u>8/27/96</u>	<u>FD2 (ppb)</u>	<u>RPD</u>
		<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>		
benzene	3	1	4	5	11

Sample ID: S1-B17-1-(02-04)

<u>Compounds</u>	<u>MDL</u>	<u>8/28/96</u>	<u>8/28/96</u>	<u>FD2(ppb)</u>	<u>RPD</u>
		<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>		
benzene	3	10	8	2	60

Sample ID: S3-B12-(09-11)

<u>Compounds</u>	<u>MDL</u>	<u>8/26/96</u>	<u>8/26/96</u>	<u>FD2(ppb)</u>	<u>RPD</u>
		<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>		
benzene	3	1	3	5	25

Sample ID: S2-B12-(18-20)

<u>Compounds</u>	<u>MDL</u>	<u>8/21/96</u>	<u>8/28/96</u>	<u>FD2 (ppb)</u>	<u>RPD</u>
		<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>		
benzene	3	ND	9	5	29

Sample ID: S3-B02-(12-14)

<u>Compounds</u>	<u>MDL</u>	<u>8/26/96</u>	<u>8/27/96</u>	<u>FD2 (ppb)</u>	<u>RPD</u>
		<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>		
benzene	3	5	4	ND	
carbon tetrachl.	4	ND	7	7	0
cis-1,2-DCE	5	ND	5	ND	
ethylbenzene	6	22	ND	ND	
m/p-xylene	16	180	ND	ND	
o-xylene	3	40	17	4	62

Sample ID: S1-B09-(09-11)

<u>Compounds</u>	<u>MDL</u>	<u>8/27/96</u>	<u>8/27/96</u>	<u>FD2 (ppb)</u>	<u>FD3(ppb)</u>	<u>Ave ± RSD</u>
		<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>			
benzene	3	2	4	8	7	6 ± 33%

**Table 14 continued. VOC Measurement Precision**

Sample ID: S2-B02-(20-22)

Compounds	8/26/96		8/27/96		RPD
	<u>MDL</u>	<u>Initial (ppb)</u>	<u>FD1 (ppb)</u>	<u>FD2 (ppb)</u>	
1,1,1-TCA	8	300	ND	ND	
1,1-DCA	6	42	ND	ND	
1,1-DCE	3	31	ND	ND	
chloroform	8	8	ND	ND	
cis-1,2-DCE	5	580	ND	ND	
ethylbenzene	6	1,000	26	ND	
m/p-xylene	16	7,700	92	ND	
o-xylene	3	2,400	81	6	82
tetrachloroethene	6	120	ND	ND	
toluene	12	39,000	120	58	35

Sample ID: S1-B1A-(09-11)

Compounds	<u>MDL</u>	Triplicate		<u>Run 3 (ppb)</u>	<u>Ave ± RSD</u>
		<u>Run 1 (ppb)</u>	<u>Run 2 (ppb)</u>		
1,1,1-TCA	8	8	41	33	23 ± 74%
1,1-DCE	3	2	20	151	12 ± 75%
chloroform	8	2	7	8	6 ± 56%
cis-1,2-DCE	5	5	4	6	4 ± 25%
ethylbenzene	6	61	39	40	47 ± 25%
m/p-xylene	16	280	150	229	220 ± 30%
o-xylene	3	69	81	85	78 ± 10%
styrene	6	6	7	9	7 ± 20%
trans-1,2-DCE	6	6	12	12	10 ± 35%

**Table 15. Field versus Laboratory VOC Data Comparison**

Sample ID	Compounds	Field (ppb)	Laboratory (ppb)
S2-B2-(20-22)	1,1-dichloroethene	30	< 50
	1,1-dichloroethane	41	< 50
	cis-1,2-dichloroethene	560	< 50
	1,1,1-trichloroethene	300	250
	toluene	37,000	2,000
	tetrachloroethane	120	< 50
	ethylbenzene	990	240
	m/p-xylene	7,400	1,200
	o-xylene	2,200	480
S3-B1-(13-15)	toluene	280,000	58,200
	ethylbenzene	3,000	14,500
	m/p-xylene	320,000	58,700
	o-xylene	83,000	25,500
S3-B23-(13-15)	1,1-dichloroethene	15	< 10
	carbon tetrachloride	6	< 10
	tetrachloroethane	23	< 10
	ethylbenzene	7	< 10
	o-xylene	17	< 10

**Table 16 Target Analyte Metals Percent Recovery for Initial Calibration Verification**

Element	Date: (mg/kg)	8/16	8/20	8/21	8/22	8/25	8/26	8/28	Average <sup>2</sup> % R	% RSD
		% R	% R	% R	% R	% R	% R	% R		
K	150.9	98	100	102	99	101	91	103	99	4
Ca	151.0	101	101	99	99	95	101	95	99	3
Mg	148.7	99	100	100	102	94	104	95	99	3
Na	149.4	103	103	103	103	104	95	110	103	4
Ag	6.00	98	96	100	100	99	92	104	98	4
Mn	0.452	96	101	99	100	100	97	100	99	2
Zn	0.600	96	101	102	101	96	107	92	99	5
Cr	0.300	99	100	99	101	101	100	103	100	1
Ni	1.200	96	101	101	98	99	93	99	98	3
Al	1.801	99	102	101	96	99	97	100	99	2
Be	0.150	96	98	98	97	97	93	96	96	2
Cu	0.751	100	100	101	99	102	91	102	99	4
V	1.503	100	99	101	101	98	95	99	99	2
Ba	6.00	99	97	99	100	103	90	106	99	5
Co	1.50	97	101	101	101	99	106	98	100	3
Fe	3.12	97	93	94	95	94	98	96	95	2
As	3.00	98	98	98	106	100	101	101	100	3
Cd	0.60	98	102	101	101	103	103	103	101	2
Pb	3.01	96	100	98	97	103	100	102	100	2
Se	3.04	97	94	97	101	99	105	98	99	3
Tl	3.06	92	87	94	95	101	98	100	95	5
Sb	1.845	96	99	100	107	93	107	100	100	5

<sup>1</sup> Sample concentration shown prepared by gravimetric dilution of a standard stock solution

obtained from Leeman Labs   <sup>2</sup> Average percent recovery (%R) is based upon n = 7 initial calibration verification percent recoveries.

**Table 17 Target Analyte Metals Percent Recovery for Continuing Calibration Verification**

Date:		8/16	8/16	8/20	8/20	8/21	8/21	8/22	8/22	8/25	8/25	8/25	8/25	8/26	8/26	8/28	8/28	Avg <sup>1</sup>	%
# of CCV	(mg/kg)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(1)	(1)	(2)	RSD	
Element	TRUE	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R	% R		
K	150.9	100	100	93	91	102	93	87	85	85	98	92	91	93	92	93	93	6	
Ca	151.0	100	99	102	104	105	104	94	96	94	102	103	103	103	112	92	96	101	4
Mg	148.7	98	96	100	107	113	110	95	99	98	103	106	107	106	115	92	103	103	6
Na	149.4	103	103	97	92	100	93	95	90	89	101	93	92	100	95	98	95	96	5
Ag	6.00	100	98	91	90	99	93	92	90	89	98	92	88	94	92	99	96	93	4
Mn	0.452	99	97	95	97	104	97	91	92	92	99	100	98	94	103	96	98	96	4
Zn	0.600	90	94	103	109	116	115	96	96	99	102	109	107	106	118	93	101	103	8
Cr	0.300	99	97	99	100	104	99	93	91	91	102	104	104	101	109	97	103	99	5
Ni	1.200	99	98	100	103	109	105	92	96	98	91	95	92	92	102	99	104	98	6
Al	1.801	101	100	102	103	105	97	92	94	93	102	101	97	99	102	96	96	99	4
Be	0.150	96	95	95	94	100	91	90	87	88	98	93	92	95	94	89	90	93	4
Cu	0.751	101	100	92	86	97	91	91	89	89	99	91	88	92	88	93	91	93	5
V	1.503	103	99	94	90	101	95	94	93	91	97	98	95	96	99	93	96	96	4
Ba	6.00	100	99	89	86	94	85	87	85	82	99	91	90	95	91	96	90	91	7
Co	1.50	97	95	95	97	107	102	94	93	96	103	108	108	105	115	102	104	100	6
Fe	3.12	101	100	92	92	97	94	90	89	91	98	100	97	96	105	93	96	95	4
As	3.00	95	95	91	97	100	100	93	93	96	100	97	98	100	105	96	100	96	3
Cd	0.60	97	97	102	110	111	111	99	102	105	112	114	118	117	113	101	114	107	7
Pb	3.01	99	99	101	107	110	109	96	97	101	111	114	117	115	110	98	111	106	7
Se	3.04	88	88	98	102	103	102	95	95	97	97	98	97	101	112	94	102	97	5
Tl	3.06	92	92	90	93	95	96	89	90	98	99	98	101	99	107	94	105	95	4
Sb	1.845	100	98	92	91	98	97	95	100	101	95	94	96	98	111	91	98	96	3

<sup>1</sup> Average percent recovery (%R) is based upon n = 16 initial calibration verification percent recoveries.

**Table 18 Target Analyte Metal Percent Recovery of Laboratory Control Standard<sup>1</sup>**

Beginning of Day	Date	8/20	8/21	8/22	8/25	8/26	8/28	Avg.	%
Element	LOQ (mg/kg)	Certified value (mg/kg)	%R	%R	%R	%R	%R	%R	RSD
Ag	0.023	0.212	105	112	113	102	94	114	107
Mn	0.0033	0.372	126	127	125	104	97	105	114
Zn	0.012	0.936	105	105	103	102	111	96	104
Cr	0.108	0.293	121	120	123	108	105	106	114
Ni	0.014	0.423	127	127	122	112	101	107	116
Al	0.069	0.966	115	115	108	112	119	113	114
Be	0.009	0.205	99	98	100	101	96	101	99
Cu	0.013	0.540	108	110	110	108	95	110	107
V	0.010	1.494	90	91	94	108	103	109	99
Ba	0.004	0.306	114	117	116	108	96	107	110
Co	0.027	1.251	102	103	102	110	112	109	106
Fe	0.012	2.049	95	97	101	103	104	106	101
Cd	0.008	0.636	89	88	90	103	98	101	95
Pb	0.115	1.728	85	84	88	104	100	102	94
End of Day									
Ag	0.023	0.212	94	101	99	87	89	99	95
Mn	0.0033	0.372	115	118	109	93	101	98	106
Zn	0.012	0.936	111	114	99	104	121	103	109
Cr	0.108	0.293	114	116	113	100	110	106	110
Ni	0.014	0.423	123	123	118	93	107	110	112
Al	0.069	0.966	104	102	96	111	125	112	108
Be	0.009	0.205	88	89	90	91	96	93	91
Cu	0.013	0.540	90	95	95	91	94	97	93
V	0.010	1.494	79	84	84	97	106	100	92
Ba	0.004	0.306	94	95	99	89	93	93	94
Co	0.027	1.251	94	100	93	106	120	109	104
Fe	0.012	2.049	91	94	91	99	108	100	97
Cd	0.008	0.636	92	94	89	109	110	110	101
Pb	0.115	1.728	86	92	88	104	110	108	98

**TABLE 19. Percent Recovery (%R) of a Laboratory Control Standard Soil Based Upon Certified Reference and Theoretical made-to Values**

Element	certified value <sup>1</sup>			made-to value <sup>3</sup>				
	(mg/kg)	Ave <sup>2</sup>	%R	% RSD	(mg/kg)	Ave <sup>2</sup>	%R	% RSD
K	3250	138	14		4224	106	14	
Ca	3710	114	7		4325	98	7	
Mg	2490	124	7		3213	96	7	
Na	167	169	14		182	155	14	
Ag	89	105	8		108	87	8	
Mn	298	132	11		348	113	11	
Zn	110	117	7		133	97	7	
Cr	71.6	122	5		82.2	107	5	
Ni	68.5	102	7		85.3	82	7	
Al	6070	202	15		7040	174	15	
Be	122	99	7		161	75	7	
Cu	173	97	8		204	83	8	
V	105	144	6		127	119	6	
Ba	161	104	10		197	85	10	
Co	94.2	115	5		127	86	5	
Fe	12500	247	5		13600	227	5	
As	65.4	121	6		87.1	91	6	
Cd	85.4	98	7		104	81	7	
Pb	70.4	105	6		87.1	85	6	
Se	152	104	4		193	82	4	
Tl	71.8	125	11		123	73	11	
Sb	38.1	358	3		186	73	3	

<sup>1</sup>Certified concentrations provided by ERA for PriorityPollutnT/CLP Soil #228

<sup>2</sup>n = 9 over seven analysis days

<sup>3</sup>Theoretical made-to concentration for PriorityPollutnT/CLP Soil #228

**Table 20 Target Analyte Metals Percent Recovery of Interferents A & AB Solutions**

Element	Date		8/20		8/21		8/22		8/25		8/26		8/28		Sol A		Sol AB	
	Sol A <sup>1</sup> values (mg/kg)	Sol AB <sup>2</sup> values (mg/kg)	Sol A	Sol AB	Avg <sup>3</sup> %	% RSD	Avg <sup>3</sup> %	% RSD										
			%R	%R														
Ca	500.6	500.6	104	104	102	102	99	94	94	97	98	101	94	95	98	4	99	4
Mg	500.8	500.8	106	106	107	108	99	95	100	103	106	109	102	99	103	3	103	5
Ag	1.000		96		101		93		98		94		106				98	5
Mn	0.504	2	102	2	105	2	91	2	100	2	94	2	100	2	10	98	5	
Zn	1.000		99		99		88		95		101		90			95	6	
Cr	0.504		98		99		90		94		92		97			95	4	
Ni	1.000		97		98		86		82		88		96			91	7	
Al	500.3	500.3	104	104	106	104	98	93	107	107	103	103	106	105	104	3	103	5
Be	0.500		100		99		89		100		93		100			97	5	
Cu	0.500		97		100		92		102		90		105			98	6	
V	0.500		97		100		90		97		94		100			96	4	
Ba	0.500	1	95	2	100	1	87	2	101	1	93	2	106	1	12	97	7	
Co	0.504		93		96		87		96		94		94			93	3	
Fe	200.5	200.5	91	90	93	92	91	86	89	92	89	92	94	93	91	2	91	3
Cd	1.000		92		93	1	84	1	96		91	1	94	1	8	92	5	
Pb	1.000		16	104	18	111	15	99	19	112	17	108	19	106	17	9	107	5

<sup>1</sup>Solution (Sol A) contains only Ca, Mg, Al, and Fe but is run for all elements <sup>2</sup>solution (Sol AB) contains both the interfering elements and the analyte elements.

<sup>2</sup>Solution (Sol AB contains both the interfering elements and the analyte elements.

<sup>3</sup>Average %R for n = 6, one per sample day of study

**TABLE 21. Comparison of Field vs. Commercial Laboratory Results for Pb and Cd**

Sample ID	Commercial				Pb	Cd
	Field (mg/kg)	Lead	Cadmium	Laboratory (mg/kg)		
S1-B11-(5-6)	19	0.48		15.4	<0.94	21
S2-B1-(16-18)	194	0.35		222	<0.89	-13
S2-B2-(20-22)	16	<0.33		29	<0.95	-58
S2-B6-(2-4)	46	<0.33		168	<1.05	-114
S2-B10-(10-12)	8	<0.33		11.6	<0.95	-37
S2-B12-(12-14)	11	<0.33		19.4	<0.84	-55
S2-B15A-(10-12)	14	<0.33		20	<1.04	-35
S3-B1-(13-15)	65	6		75.6	6.49	-15
S3-B6-(10-12)	19	0.62		28.7	<1.07	-41
S3-B14-(6-8)	5	<0.33		2.94	1.74	52
S3-B23-(13-15)	9	0.36		9.96	<0.84	-10

<sup>1</sup>(Tufts Field Lab-Fixed Base Lab)/((Tufts Field Lab + Fixed Base Lab)/2)

**Table 22. HAFB Site Sample Target Analyte Metals Measurement Precision**

Sample I.D.	S2-B1-(16-18)							S2-B2-(20-22)							S2-B4-(19-21)						
	Date	8/20			8/20			8/21													
Element	LOQ (mg/kg)	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD
K	38.0	1625	1766	872	1421	34	1264	1154	1387	1268	9	1507	3069	1409	1995	47					
Ca	0.36	947	1152	504	810	38	723	724	707	718	1	875	1080	946	967	11					
Mg	5.00	3073	3107	1787	2480	28	2243	2012	2405	2220	9	2715	3338	2722	2925	12					
Na	11.0	84.4	102	55.9	75.4	29	78.6	63.7	69.3	70.5	11	102	152	91	114.9	29					
Ag	1.00	2.74	3.25	1.64	2.38	32	2.24	1.96	2.43	2.21	11	3.13	3.85	2.55	3.17	20					
Mn	0.14	131	132	83	108	24	92.5	76.5	99.3	89.4	13	117	144	104	121	17					
Zn	0.52	21.0	21.5	12.3	17.0	28	20.3	19.8	21.3	20.5	4	21.8	34.4	18.4	24.9	34					
Cr	0.47	19.2	16.7	10.8	14.6	28	12.9	11.4	13.2	12.5	8	13.3	19.6	14.5	15.8	21					
Ni	0.60	12.2	13.2	8.1	10.4	24	8.94	9.08	9.62	9.21	4	9.70	17.24	9.28	12.1	37					
Al	3.00	7453	7901	4577	6205	27	6149	5429	6963	6180	12	6674	14259	6085	9006	51					
Be	0.04	0.300	0.317	0.209	0.257	21	0.250	0.212	0.276	0.246	13	0.282	0.621	0.250	0.384	53					
Cu	0.56	8.35	6.92	4.28	6.09	32	5.66	5.37	6.62	5.88	11	6.32	10.02	4.23	6.86	43					
V	0.41	17.0	16.6	9.7	13.5	28	12.2	10.6	13.8	12.2	13	14.2	22.0	12.4	16.2	31					
Ba	0.16	25.2	25.3	13.7	20.0	31	23.3	21.2	27.5	24.0	14	18.7	53.0	17.9	29.9	67					
Co	1.16	4.22	4.57	2.66	3.57	27	3.80	3.43	3.70	3.64	5	3.92	6.21	3.66	4.60	31					
Fe	0.52	11360	10867	6627	8983	27	6729	6167	7342	6746	9	8904	12000	7633	9512	24					
As	15.0	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Cd	0.33	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Pb	5.00	194	185	113	153	27	16.1	15.6	17.0	16.2	4	19.0	61.7	18.1	33.0	76					
Se	10.8	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Tl	19.4	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Sb	11.0	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						

**Table 22 continued. HAFB Site Sample Target Analyte Metals Measurement Precision**

Element	Sample I.D. S2-B15-(14-16)							S1-B17A-(5.75-8)							S1-B1A-(2-4)						
	Date	8/22						8/22						8/25							
		LOQ (mg/kg)	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD				
K	38.0	1134	1212	1208	1185	4	569	624	742	645	14	2259	2602	2073	2311	12					
Ca	0.36	751	845	887	828	8	385	507	551	481	18	1089	1297	1214	1200	9					
Mg	5.00	2973	2567	2376	2639	12	1086	1233	1377	1232	12	2658	3537	2661	2952	17					
Na	11.0	155	174	184	171	9	56.7	60.8	61.4	59.6	4	151	235	145	177	28					
Ag	1.00	2.47	2.43	2.69	2.53	5	1.85	1.96	2.14	1.98	7	3.57	3.87	3.68	3.71	4					
Mn	0.14	120	94.5	99.7	105	13	55.5	62.7	75.9	64.7	16	142	142	125	136	7					
Zn	0.52	38.1	37.4	41.3	38.9	5	30.9	29.3	34.5	31.6	9	34.4	32.8	31.4	32.9	5					
Cr	0.47	29.6	26.6	27.9	28.0	5	7.72	8.99	8.96	8.55	8	17.2	19.3	16.5	17.65	8					
Ni	0.60	12.8	12.0	11.7	12.2	5	10.35	4.14	4.69	6.39	54	7.43	7.98	6.06	7.16	14					
Al	3.00	6506	6234	6449	6396	2	5735	5896	6573	6068	7	8164	9268	8033	8488	8					
Be	0.04	0.243	0.259	0.272	0.26	6	0.280	0.232	0.259	0.26	9	0.299	0.281	0.278	0.286	4					
Cu	0.56	13.1	13.6	14.0	13.5	3	6.05	6.05	5.81	5.97	2	11.8	14.5	19.9	15.4	27					
V	0.41	13.7	11.8	14.0	13.1	9	11.0	12.4	12.5	12.0	7	21.1	23.6	21.1	21.9	6					
Ba	0.16	19.4	22.5	21.9	21.3	8	17.9	19.6	20.1	19.2	6	37.2	47.1	36.1	40.1	15					
Co	1.16	4.04	3.58	4.05	3.89	7	1.70	1.73	2.13	1.86	13	4.30	4.19	3.57	4.02	10					
Fe	0.52	10252	8496	8386	9045	12	6281	6612	6949	6614	5	13214	12400	12411	12675	4					
As	15.0	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Cd	0.33	6.29	6.80	6.72	6.60	4	ND	ND	ND	ND		0.440	0.475	0.434	0.450	5					
Pb	5.00	361	344	357	354	2	37.4	33.7	40.2	37	9	24.4	20.9	15.1	20	23					
Se	10.8	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Tl	19.4	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Sb	11.0	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						

**Table 22 continued. HAFB Site Sample Target Analyte Metals Measurement Precision**

Sample I.D.		S3-B02-(17-19)						S1-B11-(2-4)						S3-B16-(6-8)							
Date		8/25			8/26			8/28													
Element	LOQ (mg/kg)	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD	(1) (mg/kg)	(2) (mg/kg)	(3) (mg/kg)	Average (mg/kg)	% RSD
K	38.0	1624	1457	888	1323	29	1983	1925	2025	1978	3	1033	1114	1066	1071	4					
Ca	0.36	1304	1100	830	1078	22	1379	1173	1436	1329	10	621	829	697	716	15					
Mg	5.00	2848	2495	1949	2431	19	3122	3394	3305	3274	4	2173	2014	1953	2047	6					
Na	11.0	115	101	107	108	7	188	170	210	189	10	73.7	89.1	76.8	79.8	10					
Ag	1.00	2.62	2.14	1.44	2.07	29	3.63	3.12	2.68	3.14	15	2.04	1.84	2.08	1.99	6					
Mn	0.14	137	103	79	106	27	166	162	166	165	1	83.1	97.6	79.7	86.8	11					
Zn	0.52	25.4	23.4	96.6	48.5	86	24.9	25.0	29.5	26.4	10	21.6	54.8	13.3	29.9	74					
Cr	0.47	16.6	13.3	10.1	13.3	24	19.4	19.0	18.4	18.9	3	11.4	10.2	10.9	10.8	5					
Ni	0.60	13.6	11.7	8.84	11.4	21	7.92	8.51	9.03	8.49	7	9.35	9.05	10.24	9.55	6					
Al	3.00	6778	5932	4616	5775	19	10175	10000	11167	10447	6	5695	5842	5394	5644	4					
Be	0.04	0.255	0.211	0.162	0.209	22	0.367	0.351	0.406	0.375	8	0.168	0.197	0.250	0.205	20					
Cu	0.56	7.68	6.01	4.41	6.03	27	9.9	9.9	10.2	10.01	2	6.33	6.41	7.25	6.66	8					
V	0.41	15.6	13.7	9.76	13.0	23	23.7	23.9	24.8	24.1	2	11.6	11.0	10.4	11.0	5					
Ba	0.16	23.3	23.8	13.6	20.3	28	38.1	40.9	42.2	40.4	5	15.9	16.4	18.4	16.9	8					
Co	1.16	6.60	5.56	4.24	5.47	22	5.25	5.14	5.53	5.30	4	3.42	3.06	3.66	3.38	9					
Fe	0.52	8297	7106	6045	7149	16	13276	13276	14165	13572	4	6289	6051	5597	5979	6					
As	15.0	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Cd	0.33	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Pb	5.00	ND	ND	ND	ND		11.4	9.9	11.1	ND		ND	ND	ND	ND						
Se	10.8	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Tl	19.4	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						
Sb	11.0	ND	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND						

**Table 27. IFD and EnviroQuant Sample Data Comparison**

S2-B01-(20-22)				S2-B02-(20-22)					
PTMS031.D	RL	IFD	ENVQ	RPD	PTMS046.D	RL	IFD	ENVQ	RPD
1,1,1-Trichloroethane	20	<46.	57	NA	1,1,1-Trichloroethane	20	300	300	0%
cis-1,2-Dichloroethene	20	120	130	8%	1,1-Dichloroethane	20	41.	23	55%
Ethylbenzene	20	830	840	1%	1,1-Dichloroethene	20	30.	28	7%
m/p-Xylene	40	3400	3400	0%	cis-1,2-Dichloroethene	20	560	570	2%
o-Xylene	50	750	750	0%	Ethylbenzene	20	990	1000	1%
Tetracholoroethene	20	110	120	9%	m/p-Xylene	40	7400	7500	1%
Toluene	50	22000	21000	5%	o-Xylene	50	2300	2300	0%
					Tetracholoroethene	20	120	120	0%
					Toluene	50	37000	36000	3%
S2-B14-(08-10)									
PTMS032.D									
m/p-Xylene	40	54.	54	0%	S2-B12-(09-11)				
Toluene	50	43.	51	17%	PTMS047.D				
S2-B13-(18-20)									
PTMS036.D									
1,1,1-Trichloroethane	20	210	440	71%	S2-B01-(12-14)				
1,1-Dichloroethane	20	15.	35	77%	PTMS052.D				
1,1-Dichloroethene	20	51.	63	20%	1,1,1-Trichloroethane	20	36.	38	7%
cis-1,2-Dichloroethene	20	15000	31000	70%	Ethylbenzene	20	53.	54	2%
Ethylbenzene	20	230	460	67%	m/p-Xylene	40	140	144	3%
m/p-Xylene	40	640	1300	68%	o-Xylene	50	54.	54	1%
o-Xylene	50	190	370	64%	Tetracholoroethene	20	170	164	4%
Tetracholoroethene	20	25.	52	68%	Toluene	50	390	370	5%
Toluene	50	5500	11000	67%	S2-B02-(13-15)				
trans-1,2-Dichloroethene	20	45.	92	69%	PTMS064.D				
S2-B14-(18-20)									
PTMS038.D									
1,1,1-Trichloroethane	20	24.	22	9%	1,1,1-Trichloroethane	20	20.	33	50%
cis-1,2-Dichloroethene	20	110	140	24%	Ethylbenzene	20	550	1059	63%
Ethylbenzene	20	28.	31	10%	m/p-Xylene	40	2100	3962	61%
m/p-Xylene	40	86.	96	11%	o-Xylene	50	980	1900	64%
o-Xylene	50	67.	61	8%	Tetracholoroethene	20	540	1025	62%
Toluene	50	390	460	16%	Toluene	50	9100	16744	59%
S2-B03-(10-12)				S2-B13-(14-16)					
PTMS042.D				PTMS065.D					
Ethylbenzene	20	98.	100	2%	1,1,1-Trichloroethane	20	31.	47	40%
o-Xylene	50	170	180	6%	cis-1,2-Dichloroethene	20	380	440	15%
S2-B04-(19-21)									
PTMS044.D									
Ethylbenzene	20	410	550	29%	Ethylbenzene	20	160	178	10%
m/p-Xylene	40	640	850	28%	S2-B04-(13-15)				
o-Xylene	50	530	700	28%	PTMS066.D				
				Ethylbenzene	20	210	240	14%	
				m/p-Xylene	40	95.	109	13%	
				o-Xylene	50	1600	1789	11%	
				Tetracholoroethene	20	42.	52	22%	
				Toluene	50	390	888	78%	
RL = Reporting Limit									
IFD = Ion Fingerprint Detection Software, Sample Results (ppb)									
ENVQ = EnviroQuant Software, Sample Results (ppb)									
RPD = Relative Percent Difference									

**Table 27 continued. IFD and EnviroQuant Sample Data Comparison**

S2-B02-(20-22) FD1					S2-B02-(16-18)				
PTMS067.D	RL	IFD	ENVQ	RPD	PTMS102.D	RL	IFD	ENVQ	RPD
Ethylbenzene	20	26.	18	36%	1,1,1-Trichloroethane	20	15000	19000	24%
m/p-Xylene	40	92.	64	35%	1,1-Dichloroethane	20	3200	3700	14%
o-Xylene	50	81.	30	92%	1,1-Dichloroethene	20	870	0	200%
Toluene	50	120	110	9%	1,2-Dichloroethane	20	290	0	200%
S2-B02-(20-22) FD2					Benzene	20	24.	29	17%
PTMS069.D					Chlorobenzene	20	32.	38	18%
Toluene	50	58.	60	3%	cis-1,2-Dichloroethene	20	1600	1900	17%
S2-B15A-(14-16)					Ethylbenzene	20	1900	2400	23%
PTMS070.D					m/p-Xylene	40	12000	14000	15%
1,1,1-Trichloroethane	20	110	160	37%	o-Xylene	50	3500	4200	18%
cis-1,2-Dichloroethene	20	40.	60	39%	Tetrachloroethene	20	920	1100	18%
Ethylbenzene	20	50.	70	34%	Toluene	50	36000	120000	108%
m/p-Xylene	40	140	210	40%	Trichloroethene	20	67.	79	17%
o-Xylene	50	280	400	35%	S3-B05-(10-12)				
Toluene	50	1500	2100	33%	PTMS104.D				
S2-B03-(13-15)					cis-1,2-Dichloroethene	20	110	130	17%
PTMS071.D					Ethylbenzene	20	35.	40	14%
Ethylbenzene	20	1700	2500	38%	m/p-Xylene	40	86.	89	4%
m/p-Xylene	40	17000	27000	45%	o-Xylene	50	39.	0	200%
o-Xylene	50	4300	6500	41%	Toluene	50	140	150	7%
Toluene	50	24000	35000	37%	S3-B04-(12.5-14)				
S2-B03-(16-18)					PTMS106.D				
PTMS072.D					Ethylbenzene	20	670	680	1%
Ethylbenzene	20	640	610	5%	m/p-Xylene	40	3600	3600	0%
m/p-Xylene	40	15000	14000	7%	o-Xylene	50	1800	1800	0%
o-Xylene	50	2500	2300	8%	Toluene	50	200	190	5%
Toluene	50	9600	8700	10%	S2-B04-(16-18)				
S1-B04-(6.2-08)					PTMS107.D				
PTMS095.D					Ethylbenzene	20	190	260	31%
1,1,1-Trichloroethane	20	500	580	15%	m/p-Xylene	40	340	440	26%
1,1-Dichloroethane	20	130	150	14%	o-Xylene	50	490	530	8%
1,2-Dichloroethane	20	95.	74	26%	Toluene	50	250	550	75%
cis-1,2-Dichloroethene	20	40000	44000	10%	S2-B03-(18-20)				
Tetrachloroethene	20	330	360	9%	PTMS109.D				
trans-1,2-Dichloroethene	20	1400	1500	7%	Ethylbenzene	20	340	390	14%
Trichloroethene	20	10000	10000	0%	m/p-Xylene	40	2100	2500	17%
S1-B04-(9.5-12)					o-Xylene	50	530	590	11%
PTMS098.D					Toluene	50	930	1100	17%
cis-1,2-Dichloroethene	20	150	150	0%	RL = Reporting Limit IFD = Ion Fingerprint Detection Software, Sample Results (ppb) ENVQ = EnviroQuant Software, Sample Results (ppb) RPD = Relative Percent Difference				
Toluene	50	110	110	0%					
S3-B01-(17-19)									
PTMS100.D									
trans-1,2-Dichloroethene	20	23.	0	200%					

**Table 27 continued. IFD and EnviroQuant Sample Data Comparison**

S3-B01-(10-12)				S1-B04-(02-04)				
	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>		<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
PTMS139.D				PTMS160.D				
Ethylbenzene	20	730	720	1%	1,1,1-Trichloroethane	20	540	550
m/p-Xylene	40	9100	9000	1%	1,1-Dichloroethane	20	150	150
o-Xylene	20	1300	1200	8%	1,2-Dichloroethane	20	120	100
Toluene	20	390	370	5%	cis-1,2-Dichloroethene	20	160000	150000
					Ethylbenzene	20	38.	41
					m/p-Xylene	40	170	180
					o-Xylene	20	73.	74
					Tetrachloroethene	20	110	120
					Toluene	20	1500	1500
					trans-1,2-Dichloroethene	20	1500	1500
					Trichloroethene	20	4600	4400
								4%
S3-B02-(12-14)				S3-B04-(10-12)				
PTMS140.D				PTMS141.D				
Ethylbenzene	20	22.	21	280	280	0%	S1-B10A-(4.5-06)	
m/p-Xylene	40	130	130	110	120	9%	PTMS161D.D	
o-Xylene	20	40.	29	1000	1000	0%	cis-1,2-Dichloroethene	20
Toluene				Trichloroethene	20	300	300	0%
					61.	61	61	0%
S3-B08-(06-08)				S3-B08-(10-12)				
PTMS143.D				PTMS177.D				
cis-1,2-Dichloroethene	20	830	830	cis-1,2-Dichloroethene	20	250	320	25%
Ethylbenzene	20	460	460	Ethylbenzene	20	400	500	22%
m/p-Xylene	40	860	870	m/p-Xylene	40	1600	2100	27%
o-Xylene	20	430	420	o-Xylene	20	350	430	21%
Toluene	20	1400	1400	Toluene	20	2400	2900	19%
trans-1,2-Dichloroethene	20	32.	0	trans-1,2-Dichloroethene	20	19.	26	29%
S3-B06-(10-12)				S3-B06-(13-15)				
PTMS144.D				PTMS178.D				
Ethylbenzene	20	22.	20	1,1,1-Trichloroethane	20	80.	21	118%
m/p-Xylene	40	28.	26	1,1-Dichloroethene	20	24.	0	200%
Toluene	20	33.	27	Ethylbenzene	20	50.	36	33%
				m/p-Xylene	40	150	150	0%
				o-Xylene	20	94.	38	85%
				Styrene	20	48.	0	200%
				Tetrachloroethene	20	61.	62	2%
				Toluene	20	22.	8	99%
				trans-1,2-Dichloroethene	20	160	30	136%
S3-B05-(14-16)				S3-B23-(13-15)				
PTMS156.D				PTMS179.D				
Ethylbenzene	20	4300	4800	11%	Tetracholoroethene	20	23.	0
m/p-Xylene	40	31000	33000	6%				200%
o-Xylene	20	12000	12000	0%				
Toluene	20	15000	16000	6%				

RL = Reporting Limit

IFD = Ion Fingerprint Detection Software, Sample Results (ppb)

ENVQ = EnviroQuant Software, Sample Results (ppb)

RPD = Relative Percent Difference

**Table 27 continued. IFD and EnviroQuant Sample Data Comparison**

	<b>PTMS187.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
1,1,1-Trichloroethane	20	210	210	0%	
cis-1,2-Dichloroethene	20	4800	4900	2%	
Tetrachloroethene	20	66.	81	21%	
trans-1,2-Dichloroethene	20	180	200	11%	
Trichloroethene	20	82.	88	7%	

	<b>PTMS188.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
1,1,1-Trichloroethane	20	18.	24	26%	
cis-1,2-Dichloroethene	20	810	800	1%	
Trichloroethene	20	29.	29	0%	

	<b>PTMS193.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
Ethylbenzene	20	61.	61	0%	
m/p-Xylene	40	280	290	4%	
o-Xylene	20	69.	69	0%	

	<b>PTMS194.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
1,1,1-Trichloroethane	20	41.	6	152%	
1,1-Dichloroethene	20	20.	0	200%	
Ethylbenzene	20	39.	37	7%	
m/p-Xylene	40	150	190	24%	
o-Xylene	20	81.	69	16%	

	<b>PTMS195.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
1,1,1-Trichloroethane	20	33.	3	163%	
Ethylbenzene	20	41.	39	4%	
m/p-Xylene	40	160	200	22%	
o-Xylene	20	85.	57	39%	

	<b>PTMS196.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
Ethylbenzene	20	1700	1780	5%	
m/p-Xylene	40	1600	1600	0%	
o-Xylene	20	370	350	6%	

	<b>PTMS207.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
cis-1,2-Dichloroethene	20	42.	47	12%	
Ethylbenzene	20	40.	40	1%	
m/p-Xylene	40	44.	46	4%	
Toluene	20	140	140	0%	

	<b>PTMS208.D</b>	<b>RL</b>	<b>IFD</b>	<b>ENVQ</b>	<b>RPD</b>
cis-1,2-Dichloroethene	20	120	130	8%	
Ethylbenzene	20	230	230	0%	
m/p-Xylene	40	330	340	3%	
o-Xylene	20	110	120	9%	
Toluene	20	230	250	8%	

RL = Reporting Limit  
IFD = Ion Fingerprint Detection Software, Sample Results (ppb)  
ENVQ = EnviroQuant Software, Sample Results (ppb)  
RPD = Relative Percent Difference

**TABLE 28. VOC 5-point Calibration Linear Regression Analysis and Average RF**

Compound	Tufts purge and trap TD			Tekmar purge and trap		
	(Slope ± Std.Dev) x 10 <sup>3</sup>	(Intercept ± Error) x 10 <sup>2</sup>	RFcal ± %RSD	(Slope ± Std.Dev) x 10 <sup>3</sup>	(Intercept ± Error) x 10 <sup>2</sup>	RFcal ± %RSD
1,1,1-Trichloroethane	16.6 ± 0.1	1.23 ± 3.70	1.13 ± 4	7.39 ± 0.05	-1.81 ± 1.60	0.72 ± 3
1,1-Dichloroethane	17.2 ± 0.1	6.27 ± 4.96	1.19 ± 4	9.54 ± 0.17	-7.91 ± 6.09	0.89 ± 8
1,1-Dichloroethene	3.21 ± 0.04	0.301 ± 1.539	0.22 ± 4	0.699 ± 0.008	-0.133 ± 0.291	0.07 ± 5
1,2-Dichloroethane	6.62 ± 0.09	2.96 ± 3.17	0.46 ± 6	4.83 ± 0.04	-3.69 ± 1.34	0.45 ± 6
Benzene	19.8 ± 0.1	21.2 ± 4.6	1.51 ± 12	8.95 ± 0.10	0.567 ± 3.496	2.18 ± 4
Carbon Tetrachloride	11.1 ± 0.3	10.2 ± 11.1	0.79 ± 7	4.21 ± 0.02	-0.472 ± 0.626	0.95 ± 2
Chlorobenzene	28.7 ± 0.2	10.0 ± 8.7	2.00 ± 5	23.8 ± 0.2	1.17 ± 7.61	0.92 ± 10
Chloroform	22.3 ± 0.2	-2.35 ± 7.41	1.50 ± 4	14.7 ± 0.1	-8.19 ± 4.61	0.41 ± 4
cis-1,2-Dichloroethene	10.7 ± 0.2	2.63 ± 5.59	0.74 ± 5	5.62 ± 0.07	-1.81 ± 2.52	2.39 ± 4
Ethylbenzene	31.5 ± 2.1	144 ± 76	2.89 ± 14	34.1 ± 0.3	8.06 ± 9.78	1.39 ± 5
m/p-Xylene	31.2 ± 0.5	76.9 ± 35.1	2.33 ± 7	26.0 ± 0.2	-2.57 ± 14.13	0.54 ± 5
o-Xylene	36.9 ± 0.3	25.3 ± 9.1	2.64 ± 6	32.8 ± 0.3	1.95 ± 10.70	3.50 ± 5
Styrene	29.1 ± 0.4	8.14 ± 15.25	2.03 ± 6	33.1 ± 0.4	-11.0 ± 13.5	2.60 ± 4
Tetrachloroethene	6.25 ± 0.06	0.920 ± 2.133	0.43 ± 5	2.58 ± 0.01	0.549 ± 0.387	3.30 ± 5
Toluene	29.3 ± 0.3	21.2 ± 9.2	2.13 ± 8	16.1 ± 0.1	-3.48 ± 4.87	3.20 ± 5
trans-1,2-Dichloroethene	3.08 ± 0.03	1.29 ± 1.19	0.21 ± 4	0.620 ± 0.005	0.195 ± 0.185	0.26 ± 3
Trichloroethene	7.58 ± 0.09	1.27 ± 3.20	0.53 ± 7	3.14 ± 0.02	0.356 ± 0.590	1.58 ± 4
<b>Summary:</b>						
≤ 30%			17			17
≤ 40%			0			0
> 40%			0			0

**TABLE 28 continued. VOC 5-point Calibration Linear Regression Analysis and Average RF**

Compound	Tufts purge and trap TD			Tekmar purge and trap		
	(Slope ± Std.Dev) x 10 <sup>3</sup>	(Intercept ± Error) x 10 <sup>2</sup>	RFcal ± %RSD	(Slope ± Std.Dev) x 10 <sup>3</sup>	(Intercept ± Error) x 10 <sup>2</sup>	RFcal ± %RSD
1,1,1-Trichloroethane	11.5 ± 0.2	-6.72 ± 5.75	0.72 ± 6	8.05 ± 0.07	-0.705 ± 2.652	0.80 ± 3
1,1-Dichloroethane	15.9 ± 0.4	-7.74 ± 10.22	1.00 ± 6	9.97 ± 0.11	2.46 ± 4.31	1.02 ± 7
1,1-Dichloroethene	0.509 ± 0.009	-0.0319 ± 0.2620	0.03 ± 5	0.564 ± 0.005	0.463 ± 0.187	0.06 ± 8
1,2-Dichloroethane	6.38 ± 0.16	-4.87 ± 3.85	0.39 ± 9	5.37 ± 0.06	0.674 ± 2.103	0.54 ± 3
Benzene	12.3 ± 0.3	-4.11 ± 8.11	0.81 ± 7	7.81 ± 0.07	8.40 ± 2.78	2.35 ± 1
Carbon Tetrachloride	6.71 ± 0.17	-3.60 ± 4.10	0.43 ± 5	4.06 ± 0.02	0.388 ± 0.699	1.19 ± 1
Chlorobenzene	34.4 ± 1.5	-51.4 ± 36.7	1.95 ± 10	25.1 ± 0.2	10.9 ± 5.7	0.91 ± 19
Chloroform	35.3 ± 1.0	-26.4 ± 23.6	2.17 ± 6	17.2 ± 0.1	-1.78 ± 5.31	0.41 ± 4
cis-1,2-Dichloroethene	8.06 ± 0.24	-5.87 ± 5.89	0.49 ± 8	6.06 ± 0.03	2.55 ± 1.16	2.67 ± 8
Ethylbenzene	49.0 ± 2.2	-57.6 ± 57.3	2.94 ± 9	36.1 ± 0.2	16.9 ± 9.1	1.73 ± 5
m/p-Xylene	36.9 ± 1.7	-105 ± 82	2.14 ± 10	26.9 ± 0.1	12.8 ± 10.8	0.64 ± 5
o-Xylene	54.3 ± 2.4	-76.7 ± 59.6	3.16 ± 11	35.6 ± 0.1	11.5 ± 5.1	3.84 ± 8
Styrene	44.4 ± 2.0	-69.9 ± 50.1	2.52 ± 13	33.5 ± 0.2	15.7 ± 8.2	2.81 ± 7
Tetrachloroethene	2.84 ± 0.10	-3.20 ± 2.49	0.17 ± 7	2.27 ± 0.01	0.146 ± 0.378	3.75 ± 7
Toluene	23.9 ± 0.9	-17.7 ± 21.3	1.53 ± 10	14.3 ± 0.1	5.55 ± 2.64	3.54 ± 7
trans-1,2-Dichloroethene	0.487 ± 0.020	-0.0723 ± 0.5334	0.03 ± 9	0.610 ± 0.003	0.390 ± 0.130	0.23 ± 3
Trichloroethene	5.62 ± 0.28	-5.43 ± 6.77	0.34 ± 8	2.70 ± 0.01	0.640 ± 0.398	1.52 ± 9
<b>Summary:</b>						
≤ 30%			17			17
≤ 40%			0			0
> 40%			0			0

**TABLE 29. VOC Tufts purge and trap TD GC/MS MDL Study, 6.7 ppb Measured**

Repetitions Compounds	n = 1	2	3	4	5	6	7	Conc. Average ppb	%RSD	STDEV	MDL ppb	Tekmar P&T MDL ppb
1,1,1-Trichloroethane	2.1	1.8	1.9	1.9	1.8	1.8	1.8	1.9	5	0.10	0.3	8
1,1-Dichloroethane	1.9	1.8	1.9	1.9	1.9	1.9	1.9	1.9	3	0.06	0.2	6
1,1-Dichloroethene	3.1	2.2	1.5	2.9	3.0	3.0	3.0	2.7	22	0.6	2	3
1,2-Dichloroethane	1.8	1.7	1.7	1.7	2.0	1.8	1.9	1.8	7	0.1	0.4	13
Benzene	3.0	2.7	2.7	2.6	2.5	2.6	2.8	2.7	7	0.2	0.6	3
Carbon Tetrachloride	2.6	2.3	2.4	2.5	2.2	2.3	2.2	2.4	6	0.2	0.5	4
Chlorobenzene	1.5	1.7	1.5	1.5	1.5	1.3	1.5	1.5	7	0.1	0.3	8
Chloroform	2.2	1.9	2.0	2.0	2.1	2.1	2.0	2.	4	0.08	0.3	8
cis-1,2-Dichloroethene	1.8	1.8	1.9	1.9	1.8	1.9	1.9	1.9	2	0.03	0.1	5
Ethylbenzene	1.7	1.8	1.7	1.7	1.6	1.5	1.7	1.7	5	0.08	0.3	6
m/p-Xylene	3.6	3.8	3.6	3.5	3.5	3.2	3.5	3.5	5	0.2	0.6	16
Methylene Chloride	9.3	9.2	9.7	9.9	10.0	10.4	10.3	9.8	5	0.5	1	23
o-Xylene	1.5	1.7	1.6	1.5	1.5	1.4	1.5	1.5	6	0.08	0.3	3
Styrene	1.3	1.3	1.3	1.2	1.3	1.1	1.2	1.2	5	0.06	0.2	6
Tetrachloroethene	2.7	3.0	2.7	2.5	2.6	1.7	2.7	2.6	16	0.4	1	6
Toluene	1.9	2.0	1.9	2.0	1.9	1.8	2.0	1.9	4	0.08	0.2	10
trans-1,2-Dichloroethene	3.5	3.8	4.3	4.3	4.3	4.3	4.2	4.1	8	0.3	1	6
Trichloroethene	1.8	1.9	1.9	1.9	1.8	1.8	1.9	1.9	3	0.06	0.2	18

#### Notes

- MDL was calculated based on seven repetitions of a 6.7ppb standard
- MDL was calculated using 3.14 times the Std. Deviation
- For Tekmar MDL, See Table 13

**Table 30. Comparison of Tekmar and Tufts Purge and Trap GC/MS**

Sample ID: S2-B1-(12-14)				Sample ID: S3-B5-(10-12)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
Ethylbenzene	10	23	20	Chloroform	2	4	15
m/p-xylene	9	46	33	cis-1,2-dichloroethene	4	3	6
o-xylene	21	32	11	m/p-xylene	2	5	21
Tetracholoroethene	17	39	20	o-xylene	4	4	2
Toluene	21	57	23	Toluene	17	4	12
Sample ID: S3-B8-(6-8)				Sample ID: S2-B11-(16-18)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
Chloroform	ND	6		Toluene	1	5	34
cis-1,2-dichloroethene	12	26	18				
Ethylbenzene	3	4	8				
m/p-xylene	3	14	32				
o-xylene	10	12	6				
Toluene	3	22	38				
Sample ID: S3-B2-(12-14)				Sample ID: S2-B12-(18-20)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
m/p-xylene	4	5	10	m/p-xylene	ND	4	
Toluene	1	7	37	Styrene	ND	4	
Sample ID: S3-B3-(10-12)				Sample ID: S2-B15A-(10-12)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
m/p-xylene	1	4	29	Toluene	ND	33	
Sample ID: S2-B12-(9-11)				Sample ID: S2-B3-(18-20)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
Chloroform	2	6	24	Chloroform	2	5	22
m/p-xylene	ND	5		Ethylbenzene	39	30	7
Sample ID: S2-B13-(8-10)				Sample ID: S2-B4-(10-12)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
Toluene	1	5	33	Toluene	2	5	22
Sample ID: S2-B7-(8-10)				Sample ID: S2-B9-(6-8)			
<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>	<u>Compounds</u>	<u>PT</u>	<u>TD</u>	<u>RPD</u>
Toluene	2	4	18	m/p-xylene	7	10	9

**Table 30 continued. Comparison of Tekmar and Tufts Purge and Trap GC/MS**

Sample ID: S2-B1-(20-22)

<u>Compounds</u>	<u>PT1</u>	<u>PT2</u>	<u>PT3</u>	<u>Ave (RSD)</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>RPD</u>
Ethylbenzene	6	5	5	5 (14)	9	8	17	11 (39)	18
m/p-xylene	68	59	60	62 (8)	66	108	111	95 (26)	10
o-xylene	166	143	145	151 (8)	119	146	159	141 (14)	2
Styrene	ND	ND	ND		5	4	3	4 (32)	
Tetrachloroethene	45	34	35	38 (16)	64	85	112	87 (28)	20
Toluene	64	49	49	54 (16)	65	88	93	82 (18)	10

Sample ID: S2-B5-(8-10)

<u>Compounds</u>	<u>PT1</u>	<u>PT2</u>	<u>PT3</u>	<u>Ave (RSD)</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>RPD</u>
Toluene	ND	ND	ND		4	18	23	15 (65)	

Sample ID: S2-B14-(8-10)

<u>Compounds</u>	<u>PT1</u>	<u>PT2</u>	<u>PT3</u>	<u>Ave (RSD)</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>RPD</u>
Toluene	ND	ND	ND		5	7	4	5 (27)	

Sample ID: S2-B2-(10-12)

<u>Compounds</u>	<u>PT1</u>	<u>PT2</u>	<u>PT3</u>	<u>Ave (RSD)</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>RPD</u>
o-xylene	2	3	3	3 (22)	8	5	4	6 (35)	20
Styrene	ND	ND	ND		10	6	5	7 (31)	
Toluene	3	3	2	3 (22)	10	8	8	9 (9)	27

Sample ID: S3-B4-(12.5-14)

<u>Compounds</u>	<u>PT1</u>	<u>PT2</u>	<u>PT3</u>	<u>Ave (RSD)</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>RPD</u>
Chloroform	1	2	2	2 (35)	2	7	5	5 (55)	25
Ethylbenzene	3	2	1	2 (50)	4	9	7	7 (33)	27
m/p-xylene	5	3	3	4 (35)	13	20	10	14 (33)	29
o-xylene	15	10	6	10 (44)	13	19	14	15 (22)	10
Toluene	4	2	2	3 (46)	12	22	14	16 (33)	35

**Table 30 continued. Comparison of Tekmar and Tufts Purge and Trap GC/MS**

Sample ID: S2-B10-(6-8)

<u>Compounds</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>PT</u>	<u>RPD</u>
Toluene	7	5	4	6 (25)	ND	

Sample ID: S3-B4-(10-12)

<u>Compounds</u>	<u>TD1</u>	<u>TD2</u>	<u>TD3</u>	<u>Ave (RSD)</u>	<u>PT</u>	<u>RPD</u>
Ethylbenzene	19	11	17	16 (28)	7	20
m/p-xylene	14	20	15	17 (20)	18	5
o-xylene	23	21	21	22 (6)	38	21
Toluene	13	12	16	14 (14)	ND	

Sample ID: S3-B3-(6-8)

<u>Compounds</u>	<u>PT1</u>	<u>PT2</u>	<u>PT3</u>	<u>Ave (RSD)</u>	<u>TD</u>	<u>RPD</u>
Toluene	2	1	2	2 (35)	4	20

**Table 31. ICP/OES Instrument Detection Limit Study for Metals**

Analyte	Wavelength (nm)	Repetitions							IDL		
		Backgrd.	1	2	3	4	5	6	7	Std. Dev.	x3.143
K	766.490	766.422	1.926	2.001	2.096	2.045	1.951	2.147	2.158	0.0919	0.2889
Ca	317.933	317.902	0.0295	0.0282	0.0306	0.0303	0.0308	0.0301	0.0297	0.0009	0.0027
Mg	279.079	279.109	0.0883	0.1094	0.1192	0.1072	0.0911	0.090	0.0917	0.0122	0.0385
Na	589.592	589.535	0.4510	0.4773	0.3972	0.4081	0.4194	0.4356	0.4303	0.0270	0.0848
Ag	328.068	328.033	0.0397	0.0396	0.0406	0.0389	0.0454	0.0419	0.0381	0.0024	0.0077
Mn	257.610	257.589	0.0037	0.0041	0.0042	0.0047	0.0044	0.0044	0.0047	0.0004	0.0011
Zn	206.200	206.220	0.0120	0.0121	0.0154	0.0129	0.0122	0.0134	0.0142	0.0013	0.0040
Cr	267.716	267.690	0.0215	0.0189	0.020	0.0206	0.0218	0.0222	0.0201	0.0011	0.0036
Ni	231.604	231.583	0.0459	0.0452	0.0437	0.0463	0.0456	0.0484	0.0471	0.0015	0.0047
Al	308.215	308.248	0.1569	0.1473	0.1469	0.1577	0.1374	0.1476	0.1425	0.0073	0.0229
Be	313.042	313.011	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0000	0.0000
Cu	324.754	324.789	0.0168	0.018	0.0148	0.0168	0.0153	0.015	0.0180	0.0014	0.0043
V	292.401	292.429	0.0228	0.0218	0.0234	0.0220	0.0213	0.0208	0.0207	0.0010	0.0032
Ba	455.403	455.355	0.0025	0.0035	0.0026	0.0023	0.0031	0.0029	0.0027	0.0004	0.0013
Co	228.616	228.592	0.0179	0.025	0.0227	0.0207	0.0252	0.0206	0.0189	0.0028	0.0089
Fe	259.940	259.915	0.0159	0.0152	0.0185	0.0167	0.0173	0.0183	0.0159	0.0013	0.0040
As	193.695	193.712	0.1632	0.1446	0.1557	0.0954	0.2071	0.1382	0.1923	0.0367	0.1155
Cd	214.438	214.423	0.0057	0.0061	0.0069	0.0054	0.0072	0.0049	0.0063	0.0008	0.0026
Pb	220.353	220.335	0.1081	0.1078	0.1159	0.0993	0.1319	0.1032	0.1267	0.0122	0.0382
Se	196.026	196.038	0.1404	0.1676	0.1574	0.1366	0.1050	0.1785	0.1781	0.0266	0.0835
Tl	190.801	190.789	0.1048	0.0842	0.1338	0.0533	0.1858	0.0911	0.1682	0.0476	0.1496
Sb	206.833	206.853	0.0857	0.1219	0.0742	0.1252	0.0652	0.0787	0.0568	0.0268	0.0841

Note: EPA 40 CFR Ch. 1 (7-1-92) Pt. 136, App. B

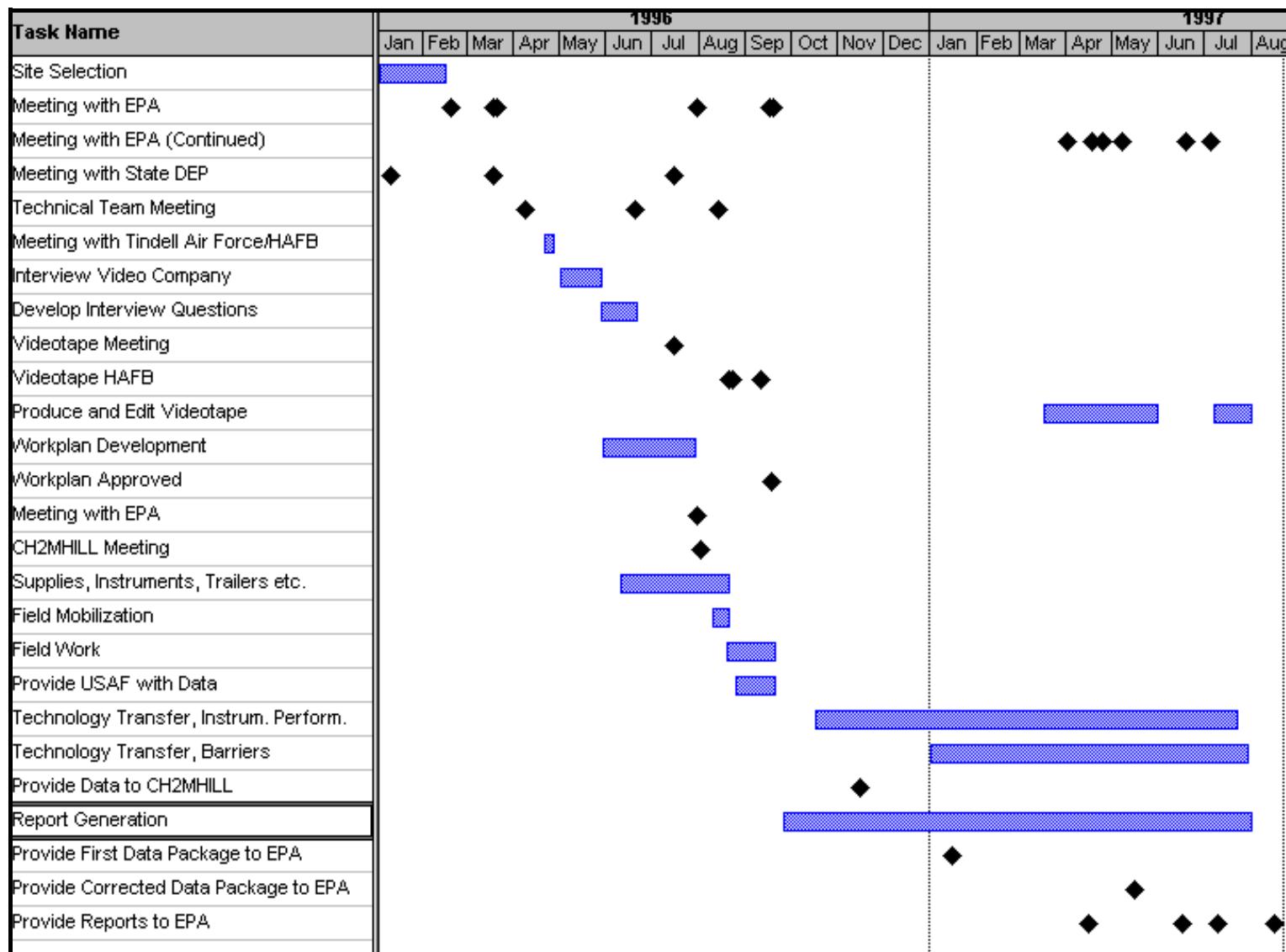
**Table 32. Summary of Detection Limits for Mobile ICP/OES**

Element	IDL	MDL IDL x 43.28	LOQ MDL x 3	LOQ Blank LOQ / 43.28	10 DAF (mg/kg)
K	0.2889	12.50	38	0.87	NA
Ca	0.0027	0.12	0.36	0.01	NA
Mg	0.0385	1.67	5.00	0.12	NA
Na	0.0848	3.67	11.0	0.25	NA
Ag	0.0077	0.33	1.00	0.02	17
Mn	0.0011	0.05	0.14	0.003	NA
Zn	0.0040	0.17	0.52	0.01	6000
Cr	0.0036	0.16	0.47	0.01	19
Ni	0.0047	0.20	0.60	0.01	65
Al	0.0229	0.99	3.00	0.07	NA
Be*	0.0003	0.01	0.04	0.001	32
Cu	0.0043	0.19	0.56	0.01	NA
V	0.0032	0.14	0.41	0.01	3000
Ba	0.0013	0.05	0.16	0.004	800
Co	0.0089	0.39	1.16	0.03	NA
Fe	0.0040	0.17	0.52	0.01	NA
As	0.1160	5.02	15.0	0.35	15
Cd	0.0026	0.11	0.33	0.008	4
Pb	0.0382	1.65	5.00	0.12	NA
Se	0.0835	3.61	10.8	0.25	3
Tl	0.1496	6.47	19.4	0.45	0.4
Sb	0.0841	3.64	11.0	0.25	3

\* Used beryllium theoretical value because experimental sensitivity was lower

## **Appendix II**

**Illustrated on the following pages are the  
Environmental Technology Initiative and HAFB Field Investigation Timelines.**



## ETI Project Timeline

Task Name	Aug 11, '96							Aug 18, '96							Aug 25, '96							Sep 1, '96							Sep 8, '96							
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	
Field Mobilization																																				
Sample Collection																																				
EPA Audit																																				
VOC Screening																																				
VOC Quantitation																																				
SVOC Quantitation																																				
Metal Quantitation																																				
Maps and Data Generation																																				
Electronic Data Provided to USAF																																				

**Field Investigation Timeline**

## **Appendix III**

**The field method Standard Operating Procedures are provided in this section**

## **STANDARD OPERATING PROCEDURE**

### **HANSCOM AFB, MASSACHUSETTS**

IRP JUN 1996, Contract No. F41624-94-D-8053, Delivery Order 0014

### **FIELD GC/MS METHOD FOR ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN SOIL AND WATER**

**SCOPE:** This procedure is for the analysis of volatile organic compounds (VOCs) in soil and water by purge and trap (P&T) concentration followed by gas chromatography/mass spectrometry (GC/MS).

**SUMMARY:** Both water and soil samples are added to a sparge vessel and purged with helium using a Tekmar 3000 concentration device. The volatile compounds are transferred from the aqueous phase to the vapor phase. The vapor is swept onto a sorbent column where the volatile organic compounds are trapped. After purging is completed the sorbent trap is flash heated and the volatile compounds are transferred via a heated line onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the volatile compounds which are then detected with a mass spectrometer.

**REQUIRES:** This procedure requires that the operator be familiar with the set-up and operation of both P&T apparatus and GC/MS. This SOP covers procedures for sample and standard preparation, calibrations, quantitation, identification, and quality control. The procedure does not cover data operating systems or reporting. A P&T concentration device, HP GCD GC/MS (a HP5890GC/5972MS can be used as well) and acquisition software are required for the procedure.

## 1.0 EQUIPMENT AND RUN CONDITIONS

**1.1 Purge & Trap Device.** A Tekmar LSC 3000 or equivalent is recommended for the Hanscom project. The Purge and Trap (P&T) is a concentration device for volatiles in both soil and water. A sparger vessel, a removable glass tube, is used to hold either the water or soil samples. A polymer trap is used to trap the volatiles as they are purged from the sample. After the volatiles are purged from the sample, the trap is flash heated and the volatiles are transferred to the GC for separation, identification, and quantitation.

**1.2 Purge & Trap Run Conditions.** Run conditions for the Hanscom project are listed below.

- Polymer trap: Supelco (# 3, Tenex, charcoal, and silica gel) or equivalent.
- Purge rate: 30 mL/minute  $\pm$  5 mL/minute.
- Purge: 5 minutes at a temperature of 40°C.
- Desorb: 2 minutes at 225°C.
- Bake: 6 minutes at 230°C.
- Mount temperature: off.
- Line and valve temperatures: 180°C.
- Bake gas delay: on for 2 minutes.

**1.3 HP G1800A GCD System Run Conditions.** The HP-GCD system consist of a gas chromatograph, an electron ionization detector (EID), and a data system. The gas chromatograph provides compound separation while the detector generates traditional retention time and abundance information. The detector is capable of scanning from 1 to 415 amu every second or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The MS requires no external cooling or an environmentally controlled room for operation. The following run conditions are recommended for the Hanscom project, however they may be altered by the field chemist based on actual site conditions.

- Carrier gas: Helium at 99.999% purity.
- Flow of 2.0 mL/minute.
- Injector temperature: 225°C.
- Initial temperature: 50°C.
- Initial time: 4 minutes.
- Rate: 8°C/minute.
- Final temperature: 150°C.
- Final time: 0 minutes.
- Run Time: 16.5 minutes.
- Detector temperature: 280°C.
- Mass range: 45 to 260 amu.
- Solvent delay: 3.0 minutes.
- Split flow: 40 mL/minute.
- Split ratio: 20:1

**1.4 Column.** A number of columns are available for volatile analysis, however, for the Hanscom project a DB-624, 60 meter, 0.25mm ID microbore column, 0.25 $\mu$ m film thickness (or equivalent) will be used.

## 2.0 CONVENTIONS.

**2.1 Standards.** Standard conventions are established to ensure consistent procedures from project to project and from operator to operator. This includes standard preparation, documentation, calculations, and tracking.

**2.1.1 Stock Standards.** Stock chemical standards will be purchased from Supelco, Inc., Chem Service, Inc., or an equivalent supplier. All standard information will be logged in a bound logbook with the pages sequentially numbered. This information will include, at a minimum:

- Vendor name supplying standards.
- Name and concentration of the standard (this can be done by attaching the label from the standard to the logbook).
- Lot number of the standard.
- Expiration date of the standard, if listed.

**2.1.2 Working Standards.** Working chemical standards may either be purchased through an approved vendor or prepared from stock standards. Working standards will be made by diluting neat or prepared stock standards. For standards made from neat solutions, the compound density or weight will be used in calculating the appropriate amount of compound and solvent to be combined. All working standards will be labeled with an identification code (see below), compound or mix name, and concentration. The associated logbook will contain the following information at a minimum:

- The Stock solution used to make the working standard, including either the information required for logging the stock solution or a reference to where that information can be found.
- Both a written description and calculation of how the working standard was prepared.
- The solvent(s) and associated lot number(s) used in preparing the standards.
- The final concentration of the working standard.
- The GC/MS code associated with the standard.
- Standard and stock solutions will be kept refrigerated at less than 10°C when not in use.
- The surrogate standard is made separately from the working standards.

**2.2 GC/MS Coding System.** The GC/MS coding system is used to trace all standards back to the vendor. All standard are required to have the appropriate code assigned when they are prepared and must be labeled accordingly. The GC/MS code will follow the format:

- FGCXXXXXXWWYZPPPP Where:
- XXXXXX is the month, day, and year that the standard was made, i.e., 041696 = April 16,1996.
- WW is the page in the logbook where the standard can be found, i.e., 01 to 99.
- Y is where the standard fell chronologically on the page, i.e., A through Z.
- Z is the logbook number where the standard can be found, i.e., 1 through 9.
- PPPP is the project identifier, i.e., USAF = United States Air Force, a short character identification of the project from 1 to 4 characters in length.

**2.3 Logbook Entries.** While the style and specific requirements for logbook entries will vary between operators and projects, certain information is required for all projects. At a minimum this will include:

- A table of contents listing what and where specific information is located.
- A listing of P&T and GC/MS run conditions and set points.
- A chemical standards preparation section containing the required standards information.
- A run log section containing at a minimum: sample identification, run number or computer file identification, sample amount (weight or volume), spiked surrogate amount and % recovery, standard code for each standard used, amount of standard(s) used, an example calculation for any calculations performed, dilution factor, and a remarks column with any pertinent information (e.g., unusual sample color or odor, unusable blanks, failed standards, coelutions, reruns, etc.).
- An equipment maintenance section containing both routine and equipment malfunction maintenance (e.g., column replacement, electronic parts replacement, GC/MS repair, replacement, or cleaning, etc.)

## 3.0 TUNING

**3.1 HP-GCD Tune.** The HP-GCD uses an auto-tune macro to tune the mass spectrometer. Three masses of the calibration compound (PFTBA) are selected: 69, 219, and 414. The procedure is automatically implemented by the GCD control software, once every 24 hours. For all 3 masses, starting with 69 amu, the MS system adjusts the mass, peak width and energy in that order until it achieves the desired values. The resolution is set to unity with a *ca.* 10% valley definition; this is done by measuring the actual peak width and adjusting the peak width parameter accordingly. The GC/MS system will be tuned at the start of each day prior to analyzing samples. The tune is considered valid for each 24 hour period. The following conditions must be met before the HP-GCD auto-tune will pass verification:

- Base peak must be mass 69 and fall between 68.80 and 69.20 amu.
- Position of mass 219 must be between 218.80 and 219.20 amu.
- Position of mass 414 must be between 413.80 and 414.20 amu.
- Position of isotope mass 70 must be between 69.80 and 70.20 amu.

- Position of isotope mass 220 must be between 219.80 and 220.20 amu.
- Position of isotope mass 415 must be between 414.80 and 415.20 amu.
- Ratio of mass 70 to mass 69 must be between 0.5 and 1.6%.
- Ratio of mass 220 to mass 219 must be between 3.2 and 5.4%.
- Ratio of mass 415 to mass 414 must be between 6.8 and 11.2%.
- Ratio of mass 219 to 69 should be > 15%.
- Ratio of mass 414 to 69 should be > 0.2%.
- Mass 69 precursor <= 3%.
- Mass 219 precursor <= 6%.
- Mass 414 precursor <= 12%.
- Ratio of mass 18 to 69 should be <20%.
- Ratio of mass 28 to 69 should be <10%.

## 4.0 CALIBRATION.

**4.1 Multilevel Calibration.** In the initial multilevel calibration, a minimum of five levels (concentrations) of standards are analyzed. The standard concentrations are selected to cover the concentration range of contaminants expected. This includes a low concentration standard at or near the method detection limit (MDL). In addition, the upper level standard needs to be within the working range of both the detector and the column. The expected calibration range is from 20 to 800 ppb.

**4.2 Daily Calibration.** After mobilizing the GC/MS unit to the field, the analyst must prepare calibration standards at a minimum of five concentrations levels for each compound by carefully adding amounts of one or more secondary dilution standards to reagent water for purging. One of the calibration standards should be at a concentration near, but above, the MDL. The other concentrations should correspond to the expected range of concentrations found in the "real-world" sample or the establishment of the GC/MS dynamic range.

**4.3 Internal Standard and Surrogate Calibration Procedure.** Prepare a solution that contains at least Toluene-d8 (internal standard), and another one that contains 4-Bromofluorobenzene (surrogate) and 1,4-Difluorobenzene (surrogate). using the procedures described in Sections 2.0 and 2.1. The concentrations of all three compounds should be 100 ppb or 100-ng/ $\mu$ L. Toluene-d8 is selected as the internal standard because of its retention characteristics relative to VOCs on USEPA's Target Compound List (TCL). It does not coelute with any of the compounds of interest; the closest eluting compound, Toluene, is baseline separated.

**4.4 Calibration Curve.** Add 5 mL of analyte free water to a luer-lock syringe. With separate syringes add the internal standard solution, surrogate solution, and the target volatile mix to the luer-lock syringe. Connect the luer-lock syringe to the Tekmar 3000 sparger apparatus and load the sample for purging. The internal standard and surrogate concentrations should be 100 ppb (inject 5  $\mu$ L of 100 ng/ $\mu$ L internal standard solution and 5  $\mu$ L of 100 ng/ $\mu$ L surrogate solution into 5.0 mL reagent water). Add 1 $\mu$ L of total volatile mix at 100 ng/ $\mu$ L to the 5 mL of reagent water (containing the internal standard and surrogate solution) for a concentration of 20 ppb.

Repeat the process for each additional concentration level by increasing the amount of volatile mix added to the 5 mL of reagent water, i.e., 5  $\mu$ L of volatile solution would be equal to 100 ppb, etc.). The internal standard amount and surrogate amounts remain constant during the calibration process. Note: The surrogate solution is normally varied in concentration as is the volatile mix, however for this project it will be kept constant to allow for alternative choices for the internal standard.

**4.5 Response Factors.** Repeat analysis one time for each concentration. Tabulate the area response of the characteristic ions against concentration for each compound and internal standard and calculate response factors (RF) for each compound using Equation 1:

$$RF = (A_X)(C_{IS})/(A_{IS})(C_X) \quad [1]$$

where,  $A_X$  = area of the standard target analyte ion current signal,  $C_{IS}$  = concentration of the internal standard,  $A_{IS}$  = area of the internal standard ion current signal,  $C_X$  = concentration of the standard target analyte.

If the RF value is constant (i.e., < 30% relative standard deviation, with no more than one third of the samples with > 30% RSD for quantitative GC/MS ) over the dynamic range, the RF can be assumed to be invariant and the average from the RF value(s) can be used for quantitation. If the average RF values for any analytes fall outside of the 40% RSD window, the instrument must be checked for mass drift and the point or points skewing the curve must be performed again.

**4.6 Continuing Calibration.** The working calibration curve or RF must be verified each working day with a mid-level calibration standard. If all of the analyte RF's from the continuing standard have respective %D's within the 30% and 40% requirements then analysis of samples may begin. If the response for 1/3 of the compounds varies from the initial calibration curve response factor by more than 40% then the test must be repeated using a fresh calibration standard at mid-level concentration. This is repeated until third failure, if the continuing calibration criteria are not achieved, then a new calibration curve with a minimum of five concentration levels will be generated.

**4.6 Closing Calibration.** The working calibration curve or RF must be verified each working day with a mid-level calibration standard (400 ppb). If all of the analyte RF's from the continuing standard have respective %D's within the 30% and 40% requirements then analysis of samples may begin. If the response for 1/3 of the compounds varies from the initial calibration curve response factor by more than 40% then the test must be repeated using a fresh calibration standard at mid-level concentration. This is repeated until third failure, if the closing calibration is still not in control, a new calibration curve must be generated and all samples analyzed during the previous calibration period must either be re-analyzed or flagged to indicate that the system was not within the QC requirements.

## 5.0 METHOD DETECTION LIMITS

**5.1 MDL Determination.** The MDLs are determined for each compound in both water and soil prior to the analysis of samples. This is accomplished by analyzing seven replicate low concentration standards near the expected MDL. From these analysis a standard deviation is calculated and multiplied by 3.14 to establish the MDL. This correlates to a student's *t* of 99% for (n-1).

**5.1.1 Water MDL.** Water MDLs will be performed using 5 mL of analyte free reagent water spiked with the target compounds at 20 ppb.

**5.1.2 Soil MDL.** Soil MDLs will be performed using a minimum of 5 grams of blank soil (ERA volatiles blank soil, catalog # 054) spiked with the target compounds at 20 ppb.

## 6.0 COMPOUND IDENTIFICATION

**6.1 Total Ion Current Mode.** Compounds will be identified using the total ion current mode (TIC). TIC's for the primary ion and at least two secondary ions for each compound of interest must be identified. The following criteria must be met to make a qualitative identification.

**6.1.1 Characteristic Ions.** The characteristic ions of each compound of interest must maximize within one scan of each other.

**6.1.2 Retention Time.** The retention time of the suspected analyte must fall within  $\pm$  30 seconds of the retention time of the actual target analyte as determined by the calibration data.

**6.1.3 Relative Peak Heights/Areas.** The relative peak heights/areas of the three characteristic ions in the TIC's must fall within  $\pm$  40% of the relative intensities of these ions according to the mass spectra obtained during calibration for targeted analytes or from a reference mass spectrum for non-targeted analytes.

**6.1.4 Structural Isomers.** Structural isomers that have very similar mass spectra and less than 30 seconds difference in retention time, can be explicitly identified only if the resolution between authentic isomers in a standard mixture is acceptable. Acceptable resolution is achieved if the baseline to valley height between the isomers is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

<u>Compounds</u>	<u>Ions</u>
Vinyl Chloride	62,64,61
1,1-Dichloroethene	96,61,98
Methylene Chloride	84,49,51,86
trans-1,2-Dichloroethene	96,61,98
1,1-Dichloroethane	63,65,83
cis-1,2-Dichloroethene	96,61,98
Chloroform	83,85,47
1,1,1-Trichloroethane	97,99,117
Carbon Tetrachloride	117,119,121
Benzene	78,52,71
1,2-Dichloroethane	62,64,98
Trichloroethene	130,95,97,132
<sup>†</sup> Toluene-d8	98,100,70
Toluene	92,91,65
Tetrachloroethene	164,129,131,166
Chlorobenzene	112,114,77
Ethylbenzene	106,91
m/p-Xylene	106,91
o-Xylene	106,91
Styrene	104,103,78,51,77
<sup>‡</sup> 1,4-Difluorobenzene	114,63,88
<sup>‡</sup> 4-Bromofluorobenzene	95,174,176
<sup>†</sup> Internal Standard,	
<sup>‡</sup> Surrogate Compounds.	

## 7.0 CALCULATIONS

**7.1 Quantitation.** When a compound has been identified the quantitation of that compound should be based on the integrated abundance from the TIC of the primary ion. If the sample produces an interference for the primary ion then a secondary characteristic ion will be used to quantitate.

**7.1.1 Water Samples.** Calculate the concentration of the compound using the internal standard calculation procedure described in Section 4.5 and Equation 2:

$$\text{Concentration } \mu\text{g/L} = (A_X)(C_{is})/(A_{is})(RF)(V_o) \quad [2]$$

where the parameters used in equation [2] are described in Section 4 and  $V_o$  = volume of water purged (mL), taking into consideration any dilutions made.

**7.1.2 Soil Samples.** Calculate the concentration of the compound using the internal standard calculation procedure described in Section 4.5 and Equation 3:

Concentration  $\mu\text{g}/\text{kg} = (A_X)(C_{IS})/(A_{IS})(RF)(W_S)(D)$  [3]

where the parameters used in equation [3] are described in Section 4,  $W_S$  = weight of sample extracted or purged (g), and  $D$  = % dry weight of sample/100, or 1 for a wet weight basis.

## 8.0 BLANKS

**8.1 Volatile Blanks.** There are two types of blanks associated with purge and trap analysis; low level method blanks and cleaning blanks.

**8.1.1 Low Level Method Blanks.** For routine analysis, a low level method blank must be analyzed before samples are analyzed. A low level method blank consist of 5 mL (or at the volume that samples are to be analyzed, i.e., 25 mL, 50 mL, etc.) of analyte free water that has a surrogate and internal standard added. Method blanks are acceptable if no target compounds are present above the reporting limit. Samples should not be analyzed until an acceptable method blank is run demonstrating that the instrument is free of interferences.

**8.1.2 Cleaning Blanks.** A cleaning blank is 5 mL of reagent water only. Blanks will be analyzed after any high level sample to ensure that carryover is not occurring. A high level sample is defined as having a concentration 5 times higher than the highest calibration point. Cleaning blanks will be analyzed until the analysis of further samples will not be affected by carryover.

## 9.0 SAMPLE PREPARATION

**9.1 Sample Preparation.** Sample analysis and preparation techniques have been adapted from protocols outlined in SW-846 3rd ed. USEPA Purge and Trap method 8260A (USEPA 1986).

**9.1.1 Water Samples.** Rinse a 5 mL (or 25 mL, depending on sample aliquot) syringe with one volume of sample. Draw the sample into the syringe, invert and remove all air adjusting the final volume to 5.0 mL. Add the appropriate amount of surrogate and internal standard directly to the sample. Deliver the sample to the sparger and start the purge process.

**9.1.2 Soil Samples.** Weigh 5 g +/- 0.5 g (or appropriate sample amount) into the sparging vessel. Add surrogate and internal standard to 5.0 mL reagent water (or to an equal amount of water that correlates to the soil amount) and add into the sparging vessel and start the purge cycle.

**9.1.3 Total Solids.** All sample results will be reported on a dry weight basis. Place approximately 10 grams of wet soil into a pre-weighed tin and dry in an oven (or use a heat lamp) until repetitive weighings show no further drying is occurring. Subtract the weight of the tin from the wet weight and from the dry weight. Divide the adjusted dry weight by the adjusted wet weight and multiply by 100 to get the percent total solids.

## 10 QUALITY CONTROL

**10.1 Quality Control.** The following procedures will be implemented by the field chemist to insure standardization of the operating procedures:

**10.1.1 Review.** The field chemist will review each chromatogram before analyzing the next sample. The review will include the calculation of surrogate recoveries, comparison of surrogate and target compound retention times to calibration standards, and the evaluation of carryover potential.

**10.1.2 Water Surrogate Recoveries.** 4-Bromofluorobenzene and 1,4-Difluorobenzene will be the primary surrogates for the Hanscom project. Surrogate recoveries for water samples must be greater than 50 percent and less than 150 percent. Water samples with surrogate recoveries of less than 50 percent must be reanalyzed to confirm matrix interferences. Water samples with recoveries greater than 150 percent will be noted in the log book. If the surrogate recovery is less than 50 percent for the water sample then the sample will be reanalyzed. If the surrogate fails the second analysis the results will be reported and the recovery noted in the logbook.

**10.1.3 Soil Surrogate Recoveries.** 4-Bromofluorobenzene and 1,4-Difluorobenzene will be the primary surrogates for the Hanscom project. Surrogate recoveries for soil samples must be greater than 30 percent and less than 200 percent. Soil samples with surrogate recoveries of less than 30 percent must be reanalyzed to confirm matrix interferences. Soil samples with recoveries greater than 200 percent will be noted in the log book. If the surrogate recovery is less than 30 percent for the soil sample then the sample will be reanalyzed. If the surrogate fails the second analysis the results will be reported and the recovery noted in the logbook.

**10.1.4 Duplicates and Triplicates.** Duplicates (or triplicates) will be analyzed for 5% of the analytical samples to calculate precision. When duplicates are analyzed a 30% RPD criteria will be used as the upper control limit. When triplicates are analyzed a 30% RSD will be used as the upper control limit. All results will be calculated for review in the logbook and in a quality control summary if requested.

## 11 REPORTING

**11.0 Reporting.** Data from all sample analyses and relevant calibration and blank analyses will be documented in the project GCMS run logbook. A quality control summary may be generated at the completion of the project and will include some or all of the following as required: initial calibrations, continuing calibrations, surrogate recoveries, method blanks, dilutions, reanalyzes, observations of the field chemist, problems and fixes, unknown peaks, raw data, etc..

## REFERENCES:

U.S. Environmental Protection Agency, 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 8260A; SW-846"; Office of Solid Waste and Emergency Response, Washington, D.C.

## **STANDARD OPERATING PROCEDURE ADDENDUM**

### **1.0 TUNING OF THE BRUKER TDGC/MS**

1.1 Bruker MS Tune - For the automatic tuning of the instrument, eight masses of the calibration compound (FC-77, a mixture of fluorinated hydrocarbons) are selected: 69, 100, 119, 169, 219, 269, 331, and 397 as well as argon ( $m/z = 70$ ) and moisture ( $m/z = 18$ ) in the carrier gas (air). The procedure is automatically implemented upon manual selection of the automatic calibration feature of the instrument. For all 10 masses, starting with 18 amu, the MS system adjusts the mass, peak width and energy in that order until it achieves the optimized values. The resolution is set to unity with a ca. 10% valley definition; this is done by measuring the actual peak width and adjusting the peak width parameter accordingly.

### **2.0 TDGC/MS FIELD SCREENING METHOD FOR VOLATILES**

2.1 Thermal desorption gas chromatograph/mass spectrometer (Bruker Instruments, Billerica, MA) will be used to initially screen the 4-ft. collection liners from the geoprobe. The GC will be held isothermal at 50°C, the Bruker thermal desorption probe will be held isothermal at 45°C, and the mass spectrometer assigned to target compounds known to be present (from past data) at the site.

2.1.1 At the start of each day on site, the Bruker TDGC/MS is tuned according to the criteria listed above. 620-ng of target analytes are then injected into the center of a geoprobe sleeve filled with blank soil. After 2 minutes, the thermal desorption probe is held over a hole cut in the sleeve directly above the location of the injection, and responses are noted for each target analyte. This is to test the sensitivity of the method at approximately the 10-ppb level (based on the sample size of 62-g, the approximate weight of indigenous soil contained in a 2-in slice of the geoprobe sleeve). A one point calibration is performed using the above procedure at approximately the 40-ppb level in order to provide rough quantitative data.

2.1.2 Each 4-ft geoprobe plastic sleeve received on site is marked to show 1-ft sections along the length of the tube. A hole is cut using a clean knife at the approximate center of the 1-ft section. The Bruker's thermal desorption probe is then held directly over the hole and responses are noted for each target analyte. If there is no response after a period of 1-min, the section is considered blank. This procedure is then repeated for each 1-ft section of the sleeve, and responses noted.

2.1.3 Data generated using this screening method is used to determine which, if any, 2-ft section of the geoprobe boring is to be sampled for further laboratory analysis. This data is also used to quickly determine whether more 'step-out' boring samples are needed at a particular boring location.

2.1.4 The following analytes are to be targeted for on-site screening analysis:

Vinyl Chloride  
Dichloroethene  
Dichloroethane  
Trichloroethene  
Tricholorethane  
Tetrachloroethene  
Chloroform  
Benzene  
Toluene  
Ethylbenzene  
Xylene

## STANDARD OPERATING PROCEDURE

### HANSCOM AFB, MASSACHUSETTS IRP JUN 1996, Contract No. F41624-94-D-8053, Delivery Order 0014

#### FIELD TDGC/MS METHOD FOR ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN SOIL AND WATER

**SCOPE:** This procedure is for the analysis of volatile organic compounds (VOCs) in soil and water by purge and trap (P&T) concentration followed by Thermal Desorption Gas Chromatography/Mass Spectrometry (TDGC/MS).

**SUMMARY:** Both water and soil samples are added to a sparge vessel and purged with high purity nitrogen (or equivalent). The purgeables are transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile organic compounds are trapped. After purging is completed the tube is placed into an thermal desorption injection port attached to the GC oven. The sorbent tube is heated and flushed with carrier gas. The VOC's are thermally desorbed from the sorbent and swept onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the volatile compounds which are then detected with a mass spectrometer.

**REQUIRES:** This procedure requires that the operator be familiar with the set-up and operation of both P&T apparatus and TDGC/MS. This SOP covers procedures for sample and standard preparation, calibrations, quantitation, identification, and quality control. The procedure does not cover data operating systems or reporting. A P&T concentration device, HP GCD TDGC/MS (or equivalent) and acquisition software are required for the procedure.

#### 1.0 EQUIPMENT AND RUN CONDITIONS

**1.1 Purge & Trap Device.** The purge and trap device consists of three separate parts, the purge gas, the purge vessel, and the trap.

**1.1.1** The sample purge vessel is designed to hold 20-mL, 40-mL, or 100-mL equivalent samples of water and soil. The purge vessel used for this method is available commercially by Wheaton Scientific, Millville, NJ. If samples of higher concentration are to be analyzed, the 20-mL impinger can be used. The purge gas must be introduced not more than 5-mm from the base of the water column. High purity nitrogen gas is attached at the top of the glass tube which is used to introduce purge gas through the water and soil samples.

**1.1.2** The trap used in these methods, consists of a 100-mm long, 8-mm OD glass tube (SKC, Eighty Four, PA). The tubes can be filled with different sorbents for optimum trapping of VOCs. A 100-mg Tenax/50 mg Charcoal combination is recommended for the Hanscom project.

**1.2 Purge & Trap Run Conditions.** Run conditions for the Hanscom project are listed below.

- Polymer tubes: SKC, Supelco or equivalent (Tenex to charcoal 2:1).
- Purge rate: 30 mL/minute ± 5 mL/minute.
- Purge: 5 minutes at a temperature of ambient temperature.
- Predesorb in the Thermal Desorber for 3 minutes at 235 °C.
- Desorb: 2 minutes at 235°C.
- Close valve and open Thermal Desorber, bake at 235°C.
- Bake: overnight at 180°C in a separate oven with nitrogen at low flow.

**1.3 HP G1800A GCD System Run Conditions.** The HP-GCD system consist of a gas chromatograph, an electron ionization detector (EID), and a data system. The gas chromatograph provides compound separation while the detector generates traditional retention time and abundance information. The detector is capable of scanning from 1 to 415 amu every second or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The MS requires no external cooling or an environmentally controlled room for operation. The following run conditions are recommended for the Hanscom project, however they may be altered by the field chemist based on actual site conditions.

- Carrier gas: Helium at 99.999% purity.
- Flow of 2.0 mL/minute.
- Injector temperature: 225°C.
- Thermal Desorber: 235°C.
- Initial temperature: 0°C.
- Initial time: 1 minute.
- Rate: 50°C/minute.
- Final temperature: 50°C.
- Final time: 2 minutes.
- Rate A: 14°C/minute.
- Final temperature A: 180°C.

- Final time: 2.7 minutes.
- Run Time: 16.0 minutes.
- Detector temperature: 280°C.
- Mass range: 45 to 260 amu.
- Solvent delay: 1.0 minutes.
- Split flow: 40 mL/minute.
- Split ratio: 20:1

**1.4 Column.** A number of columns are available for volatile analysis, however, for the Hanscom project a DB-624, 60 meter, 0.25mm ID microbore column, 0.25 $\mu$ m film thickness (or equivalent) will be used.

## 2.0 CONVENTIONS.

**2.1 Standards.** Standard conventions are established to ensure consistent procedures from project to project and from operator to operator. This includes standard preparation, documentation, calculations, and tracking.

**2.1.1 Stock Standards.** Stock chemical standards will be purchased from Supelco, Inc., Chem Service, Inc., or an equivalent supplier. All standard information will be logged in a bound logbook with the pages sequentially numbered. This information will include, at a minimum:

- Vendor name supplying standards.
- Name and concentration of the standard (this can be done by attaching the label from the standard to the logbook).
- Lot number of the standard.
- Expiration date of the standard, if listed.

**2.1.2 Working Standards.** Working chemical standards may either be purchased through an approved vendor or prepared from stock standards. Working standards will be made by diluting neat or prepared stock standards. For standards made from neat solutions, the compound density or weight will be used in calculating the appropriate amount of compound and solvent to be combined. All working standards will be labeled with an identification code (see below), compound or mix name, and concentration. The associated logbook will contain the following information at a minimum:

- The Stock solution used to make the working standard, including either the information required for logging the stock solution or a reference to where that information can be found.
- Both a written description and calculation of how the working standard was prepared.
- The solvent(s) and associated lot number(s) used in preparing the standards.
- The final concentration of the working standard.
- The GC/MS code associated with the standard.

- Standard and stock solutions will be kept refrigerated at less than 10°C when not in use.
- The surrogate standard is made separately from the working standards.

**2.2 GC/MS Coding System.** The GC/MS coding system is used to trace all standards back to the vendor. All standard are required to have the appropriate code assigned when they are prepared and must be labeled accordingly. The GC/MS code will follow the format:

- FGCXXXXXXWWYZPPPP Where:
- XXXXXX is the month, day, and year that the standard was made, i.e., 041696 = April 16,1996.
- WW is the page in the logbook where the standard can be found, i.e., 01 to 99.
- Y is where the standard fell chronologically on the page, i.e., A through Z.
- Z is the logbook number where the standard can be found, i.e., 1 through 9.
- PPPP is the project identifier, i.e., USAF = United States Air Force, a short character identification of the project from 1 to 4 characters in length.

**2.3 Logbook Entries.** While the style and specific requirements for logbook entries will vary between operators and projects, certain information is required for all projects. At a minimum this will include:

- A table of contents listing what and where specific information is located.
- A listing of P&T and GC/MS run conditions and set points.
- A chemical standards preparation section containing the required standards information.
- A run log section containing at a minimum: sample identification, run number or computer file identification, sample amount (weight or volume), spiked surrogate amount and % recovery, standard code for each standard used, amount of standard(s) used, an example calculation for any calculations performed, dilution factor, and a remarks column with any pertinent information (e.g., unusual sample color or odor, unusable blanks, failed standards, coelutions, reruns, etc.).

## 3.0 TUNING

**3.1 HP-GCD Tune.** The HP-GCD uses an auto-tune macro to tune the mass spectrometer. Three masses of the calibration compound (PFTBA) are selected: 69, 219, and 502. The procedure is automatically implemented by the GCD control software, once every 24 hours. For all 3 masses, starting with 69 amu, the MS system adjusts the mass, peak width and energy in that order until it achieves the desired values. The resolution is set to unity with a *ca.* 10% valley definition; this is done by measuring the actual peak width and adjusting the peak width parameter accordingly. The GC/MS system will be tuned at the start of each day prior to analyzing samples. The tune is considered valid for each 24 hour period. The following conditions must be met before the HP-GCD auto-tune will pass verification:

- Base peak must be mass 69 and fall between 68.80 and 69.20 amu.

- Position of mass 219 must be between 218.80 and 219.20 amu.
- Position of mass 414 must be between 413.80 and 414.20 amu.
- Position of isotope mass 70 must be between 69.80 and 70.20 amu.
- Position of isotope mass 220 must be between 219.80 and 220.20 amu.
- Position of isotope mass 415 must be between 414.80 and 415.20 amu.
- Ratio of mass 70 to mass 69 must be between 0.5 and 1.6%.
- Ratio of mass 220 to mass 219 must be between 3.2 and 5.4%.
- Ratio of mass 415 to mass 414 must be between 6.8 and 11.2%.
- Ratio of mass 219 to 69 should be > 15%.
- Ratio of mass 414 to 69 should be > 0.2%.
- Mass 69 precursor <= 3%.
- Mass 219 precursor <= 6%.
- Mass 414 precursor <= 12%.
- Ratio of mass 18 to 69 should be <20%.
- Ratio of mass 28 to 69 should be <10%.

## 4.0 CALIBRATION.

**4.1 Multilevel Calibration.** In the initial multilevel calibration, a minimum of five levels (concentrations) of standards are analyzed. The standard concentrations are selected to cover the concentration range of contaminants expected. This includes a low concentration standard at or near the method detection limit (MDL). In addition, the upper level standard needs to be within the working range of both the detector and the column. The expected calibration range is from 20 to 800 ppb.

**4.2 Daily Calibration.** After mobilizing the GC/MS unit to the field, the analyst must prepare calibration standards at a minimum of five concentrations levels for each compound by carefully adding amounts of one or more secondary dilution standards to reagent water for purging. One of the calibration standards should be at a concentration near, but above, the MDL. The other concentrations should correspond to the expected range of concentrations found in the "real-world" sample or the establishment of the GC/MS dynamic range.

**4.3 Internal Standard and Surrogate Calibration Procedure** Prepare a solution that contains at least Toluene-d8 (internal standard), and another one that contains 4-Bromofluorobenzene (surrogate) and 1,4-Difluorobenzene (surrogate). using the procedures described in Sections 2.0 and 2.1. The concentration of all three compounds should be 66.7 ppb or 100-ng/ $\mu$ L. Toluene-d8 is selected as the internal standard because of its retention characteristics relative to VOCs on USEPA's Target Compound List (TCL). It does not coelute with any of the compounds of interest; the closest eluting compound, toluene, is baseline separated.

**4.4 Calibration Curve.** Add 15 mL of analyte free water to the 20 mL impinger. With separate syringes add the internal standard solution, surrogate solution, and the target volatile mix to the impinger. Connect the top of the impinger, attach the Tenex/charcoal sorption tube and start the nitrogen purge flow. The internal standard and surrogate concentrations should be

66.7 ppb (inject 10  $\mu\text{L}$  of 100 ng/ $\mu\text{L}$  internal standard solution and 10  $\mu\text{L}$  of 100 ng/ $\mu\text{L}$  surrogate solution into 15.0 mL reagent water). Add 2 $\mu\text{L}$  of total volatile mix at 100 ng/ $\mu\text{L}$  to the 15 mL of reagent water (containing the internal standard and surrogate solution) for a concentration of 13.3 ppb. Repeat the process for each additional concentration level by increasing the amount of volatile mix added to the 5 mL of reagent water, i.e., 5  $\mu\text{L}$  of volatile solution would be equal to 33.3 ppb, etc.). The internal standard amount and surrogate amounts remain constant during the calibration process. Note: The surrogate solution is normally varied in concentration as is the volatile mix, however for this project it will be kept constant to allow for alternative choices for the internal standard.

**4.5 Response Factors.** Repeat analysis one time for each concentration. Tabulate the area response of the characteristic ions against concentration for each compound and internal standard and calculate response factors (RF) for each compound using Equation 1:

$$\text{RF} = (A_X)(C_{\text{IS}})/(A_{\text{IS}})(C_X) \quad [1]$$

where  $A_X$  = area of the standard target analyte ion current signal,  $C_{\text{IS}}$  = concentration of the internal standard,  $A_{\text{IS}}$  = area of the internal standard ion current signal, and  $C_X$  = concentration of the standard target analyte.

If the RF value is constant (i.e., < 30% relative standard deviation, with no more than one third of the samples with > 30% RSD for quantitative GC/MS ) over the dynamic range, the RF can be assumed to be invariant and the average from the RF value(s) can be used for quantitation. If the average RF values for any analytes fall outside of the 40% RSD window, the instrument must be checked for mass drift and the point or points skewing the curve must be performed again.

**4.6 Continuing Calibration.** The working calibration curve or RF must be verified each working day with a mid-level calibration standard. If all of the analyte RFs from the continuing standard have respective %Ds within the 30% and 40% requirements then analysis of samples may begin. If the response for 1/3 of the compounds varies from the initial calibration curve response factor by more than 40% then the test must be repeated using a fresh calibration standard at mid-level concentration. This is repeated until third failure, if the continuing calibration criteria are not achieved, then a new calibration curve with a minimum of five concentration levels will be generated.

**4.7 Closing Calibration.** The working calibration curve or RF must be verified each working day with a mid-level calibration standard. If all of the analyte RFs from the continuing standard have respective %Ds within the 30% and 40% requirements then analysis of samples may begin. If the response for 1/3 of the compounds varies from the initial calibration curve response factor by more than 40% then the test must be repeated using a fresh calibration standard at mid-level concentration. This is repeated until third failure, if the closing calibration is still not in control, a new calibration curve must be generated and all samples analyzed during the previous calibration period must either be re-analyzed or flagged to indicate that the system was not within the QC requirements..

## 5.0 METHOD DETECTION LIMITS

**5.1 MDL Determination.** The MDLs are determined for each compound in both water and soil prior to the analysis of samples. This is accomplished by analyzing seven replicate low concentration standards near the expected MDL. From these analysis a standard deviation is calculated and multiplied by 3.14 to establish the MDL. This correlates to a student's  $t$  of 99% for (n-1).

**5.1.1 Water MDL.** Water MDLs will be performed using 15 mL of analyte free reagent water spiked with the target compounds at 6.7 ppb.

**5.1.2 Soil MDL.** Soil MDLs will be performed using a minimum of 15 grams of blank soil (ERA volatiles blank soil, catalog # 054) spiked with the target compounds at 6.7 ppb.

## 6.0 COMPOUND IDENTIFICATION

**6.1 Total Ion Current Mode.** Compounds will be identified using the total ion current mode (TIC). TICs for the primary ion and at least two secondary ions for each compound of interest must be identified. The following criteria must be met to make a qualitative identification.

**6.1.1 Characteristic Ions.** The characteristic ions of each compound of interest must maximize within one scan of each other.

**6.1.2 Retention Time.** The retention time of the suspected analyte must fall within  $\pm$  30 seconds of the retention time of the actual target analyte as determined by the calibration data.

**6.1.3 Relative Peak Heights/Areas.** The relative peak heights/areas of the three characteristic ions in the TICs must fall within  $\pm$  40% of the relative intensities of these ions according to the mass spectra obtained during calibration for targeted analytes or from a reference mass spectrum for non-targeted analytes.

**6.1.4 Structural Isomers.** Structural isomers that have very similar mass spectra and less than 30 seconds difference in retention time, can be explicitly identified only if the resolution between authentic isomers in a standard mixture is acceptable. Acceptable resolution is achieved if the baseline to valley height between the isomers is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

<u>Compounds</u>	<u>Ions</u>
Vinyl Chloride	62,64,61
1,1-Dichloroethene	96,61,98
Methylene Chloride	84,49,51,86
trans-1,2-Dichloroethene	96,61,98
1,1-Dichloroethane	63,65,83
cis-1,2-Dichloroethene	96,61,98
Chloroform	83,85,47
1,1,1-Trichloroethane	97,99,117
Carbon Tetrachloride	117,119,121
Benzene	78,52,71
1,2-Dichloroethane	62,64,98
Trichloroethene	130,95,97,132
<sup>†</sup> Toluene-d8	98,100,70
Toluene	92,91,65
Tetrachloroethene	164,129,131,166
Chlorobenzene	112,114,77
Ethylbenzene	106,91
m/p-Xylene	106,91
o-Xylene	106,91
Styrene	104,103,78,51,77
<sup>‡</sup> 1,4-Difluorobenzene	114,63,88
<sup>‡</sup> 4-Bromofluorobenzene	95,174,176
<sup>†</sup> Internal Standard,	
<sup>‡</sup> Surrogate Compounds.	

## 7.0 CALCULATIONS

**7.1 Quantitation.** When a compound has been identified the quantitation of that compound should be based on the integrated abundance from the TIC of the primary ion. If the sample produces an interference for the primary ion then a secondary characteristic ion will be used to quantitate.

**7.1.1 Water Samples.** Calculate the concentration of the compound using the internal standard calculation procedure described in Section 4.5 and Equation 2:

$$\text{Concentration } \mu\text{g/L} = (A_X)(C_{IS})/(A_{IS})(RF)(V_o) \quad [2]$$

where the parameters used in equation [2] are described in Section 4, and  $V_o$  = volume of water purged (mL), taking into consideration any dilutions made.

**7.1.2 Soil Samples.** Calculate the concentration of the compound using the internal standard calculation procedure described in Section 4.5 and Equation 3:

Concentration  $\mu\text{g}/\text{kg} = (A_X)(C_{is})/(A_{is})(RF)(W_s)(D)$  [3]

where the parameters used in equation [3] are described in Section 4,  $W_s$  = weight of sample extracted or purged (g), and  $D$  = % dry weight of sample/100, or 1 for a wet weight basis.

## 8.0 BLANKS

**8.1 Volatile Blanks.** There are two types of blanks associated with purge and trap analysis; low level method blanks and cleaning blanks.

**8.1.1 Low Level Method Blanks.** For routine analysis, a low level method blank must be analyzed before samples are analyzed. A low level method blank consist of 15 mL (or at the volume that samples are to be analyzed, i.e., 25 mL, 50 mL, etc.) of analyte free water that has a surrogate and internal standard added. Method blanks are acceptable if no target compounds are present above the reporting limit. Samples should not be analyzed until an acceptable method blank is run demonstrating that the instrument is free of interferences

**8.1.2 Cleaning Blanks.** A cleaning blank is 15 mL of reagent water only. Blanks will be analyzed after any high level sample to ensure that carryover is not occurring. A high level sample is defined as having a concentration 5 times higher than the highest calibration point. Cleaning blanks will be analyzed until the analysis of further samples will not be affected by carryover.

## 9.0 SAMPLE PREPARATION

**9.1 Sample Preparation.** Sample analysis and preparation techniques have been adapted from protocols outlined in SW-846 3rd ed. USEPA Purge and Trap method 8260A (USEPA 1986).

**9.1.1 Water Samples.** Rinse a 25 mL syringe with one volume of sample. Draw the sample into the syringe, invert and remove all air adjusting the final volume to 15.0 mL. Add the appropriate amount of surrogate and internal standard directly to the sample. Deliver the sample to the impinger, connect the Tenex/charcoal sorption tube, start the nitrogen purge gas and start the purge process. After the purge cycle is complete, remove the sorbent trap and transfer to the thermal desorber for analysis.

**9.1.2 Soil Samples.** Weigh 15 g +/- 0.5 g (or appropriate sample amount) into the impinger. Add surrogate and internal standard to 10.0 mL reagent water, deliver the solution to the impinger, connect the Tenex/charcoal sorption tube, start the nitrogen purge gas and start the purge process. After the purge cycle is complete, remove the sorbent trap and transfer to the thermal desorber for analysis.

**9.1.3 Total Solids.** All sample results will be reported on a dry weight basis. Place approximately 10 grams of wet soil into a pre-weighed tin and dry in an oven (or use a heat lamp) until repetitive weightings show no further drying is occurring. Subtract the weight of the tin

from the wet weight and from the dry weight. Divide the adjusted dry weight by the adjusted wet weight and multiply by 100 to get the percent total solids.

## 10 QUALITY CONTROL

**10.1 Quality Control.** The following procedures will be implemented by the field chemist to insure standardization of the operating procedures:

**10.1.1 Review.** The field chemist will review each chromatogram before analyzing the next sample. The review will include the calculation of surrogate recoveries, comparison of surrogate and target compound retention times to calibration standards, and the evaluation of carryover potential.

**10.1.2 Water Surrogate Recoveries.** 4-Bromofluorobenzene and 1,4-Difluorobenzene will be the primary surrogates for the Hanscom project. Surrogate recoveries for water samples must be greater than 50 percent and less than 150 percent. Water samples with surrogate recoveries of less than 50 percent must be reanalyzed to confirm matrix interferences. Water samples with recoveries greater than 150 percent will be noted in the log book. If the surrogate recovery is less than 50 percent for the water sample then the sample will be reanalyzed. If the surrogate fails the second analysis the results will be reported and the recovery noted in the logbook.

**10.1.3 Soil Surrogate Recoveries.** 4-Bromofluorobenzene and 1,4-Difluorobenzene will be the primary surrogates for the Hanscom project. Surrogate recoveries for soil samples must be greater than 30 percent and less than 200 percent. Soil samples with surrogate recoveries of less than 30 percent must be reanalyzed to confirm matrix interferences. Soil samples with recoveries greater than 200 percent will be noted in the log book. If the surrogate recovery is less than 30 percent for the soil sample then the sample will be reanalyzed. If the surrogate fails the second analysis the results will be reported and the recovery noted in the logbook.

**10.1.4 Duplicates and Triplicates.** Duplicates (or triplicates) will be analyzed after every twenty samples to calculate precision. When duplicates are analyzed a 30% RPD criteria will be used as the upper control limit. When triplicates are analyzed a 30% RSD will be used as the upper control limit. All results will be calculated for review in the logbook and in a quality control summary if requested.

## 11 REPORTING

**11.0 Reporting.** Data from all sample analyses and relevant calibration and blank analyses will be documented in the project GCMS run logbook. A quality control summary may be generated at the completion of the project and will include some or all of the following as required: initial calibrations, continuing calibrations, surrogate recoveries, method blanks, dilution's, reanalyzes, observations of the field chemist, problems and fixes, unknown peaks, raw data, etc..

## REFERENCES:

U.S. Environmental Protection Agency, 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 8260A; SW-846"; Office of Solid Waste and Emergency Response, Washington, D.C.

**STANDARD OPERATING PROCEDURE****HANSCOM AFB, MASSACHUSETTS**  
IRP JUN 1996, Contract No. F41624-94-D-8053, Delivery Order 0014**FIELD TDGC/MS METHOD FOR ANALYSIS OF PAHs AND PCBs IN SOIL**

**SCOPE:** The method is capable of providing either semi-quantitative or quantitative analysis for the presence of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyl's (PCBs) in organic extracts prepared from non-aqueous solid materials. The method uses a solvent extraction followed by thermal desorption gas chromatography/mass spectrometry (TDGC/MS). Concentrations reported for PCBs will be reported as Total PCB levels. The PAH analyzed by this method are as follows:

Polycyclic Aromatic Hydrocarbon	CAS Number <sup>a</sup>
Naphthalene	91-20-3
Acenaphthylene	208-96-8
Acenaphthene	83-32-9
Fluorene	86-73-7
<sup>1</sup> Phenanthrene	85-01-8
<sup>1</sup> Anthracene	120-12-7
<sup>2</sup> Fluoranthene	206-44-0
<sup>2</sup> Pyrene	129-00-0
<sup>3</sup> Chrysene	218-01-9
<sup>3</sup> Benzo(a)anthracene	56-55-3
Benzo(a)pyrene	50-32-8
<sup>4</sup> Benzo(b)fluoranthene	205-99-2
<sup>4</sup> Benzo(k)fluoranthene	207-08-9
<sup>5</sup> Dibenz(a,h)anthracene	53-70-3
<sup>5</sup> Indeno(1,2,3-cd)pyrene	193-39-5

<sup>a</sup>CAS Number = Chemical Abstracts Service registry number  
Note: Compounds with same superscript number coelute.

**SUMMARY:** The soil sample is micro-extracted using methylene chloride. An aliquot of the extract and a known amount of the internal standard are injected onto a thermal desorption tube. The solvent is allowed to volatilize and the remaining compounds are then thermally desorbed and analyzed by the GC/MS system.

**REQUIRES:** This procedure requires that the operator be familiar with the set-up and operation of the GC/MS system. This SOP covers procedures for sample and standard preparation, calibrations, quantitation, identification, and quality control. The procedure does not cover data operating systems or reporting. A TDGC/MS (Tufts University model or equivalent) and acquisition software are required for the procedure.

## 1.0 EQUIPMENT AND RUN CONDITIONS

**1.1 Thermal Desorber Run Conditions.** The thermal desorber is attached directly to the TDGC/MS injection port. The desorption tube is inserted into the desorber at the start of analysis. The sample is flash heated off from the sorbent tube onto the capillary column for separation and identification.

- Desorber temperature: 280°C.
- Desorb time: 1.5 minutes

**1.2 TDGC/MS (HP5972) System Run Conditions.** The TDGC/MS system consist of a gas chromatograph, a mass spectrometer , and a data system. The gas chromatograph provides compound separation while the mass spectrometer generates ion abundance information. The following run conditions are recommended for the Hanscom project, however they may be altered by the field chemist based on actual site conditions.

**1.3 TDGC Conditions.** The analytes are thermally desorbed off of the thermal desorption tube by heating the thermal desorption port isothermally at 280°C. The sample is introduced at the head of the capillary column by volatilization at 280°C, the carrier gas flow rate through the thermal desorption port, and the temperature gradient between the thermal desorption port and the initial column temperature. The column temperature is held at 150°C for 60 seconds followed by linear temperature programmed heating to 320°C at 50°C/minute. Finally, the temperature program is held isothermal, heating period of 330 seconds at 320°C. The total analysis time (including oven cooling time) is approximately 15 minutes.

**1.4 MS Conditions.** MS data is collected as a total ion current chromatogram (TIC). The mass range is 125 and 500 amu (Tufts TDGC/MS) with the MS scan time of 1-2 sec depending upon the target analytes at a specific site.

- Carrier gas: Helium at 99.999% purity.
- Flow of 1.0 mL/minute.
- Injector temperature: 280°C.
- Initial temperature: 150°C.
- Rate: 50°C/minute.
- Final temperature: 320°C.
- Final time: 5.5 minutes.
- Run Time: 10 minutes.
- Interface temperature: 280°C.
- Mass range: 120 to 500 amu.
- Solvent delay: 1.5 minutes.

**1.5 Column.** A number of columns are available for semi-volatile analysis, however, for the Hanscom project a DB-5MS, 20 meter, 0.25mm ID microbore column, 0.25µm film thickness (or equivalent) will be used.

## 2.0 CONVENTIONS.

**2.1 Standards.** Standard conventions are established to ensure consistent procedures from project to project and from operator to operator. This includes standard preparation, documentation, calculations, and tracking.

**2.1.1 Stock Standards.** Stock chemical standards will be purchased from Supelco, Inc., Chem Service, Inc., or an equivalent supplier. All standard information will be logged in a bound logbook with the pages sequentially numbered. This information will include, at a minimum:

- Vendor name supplying standards.
- Name and concentration of the standard (this can be done by attaching the label from the standard to the logbook).
- Lot number of the standard.
- Expiration date of the standard, if listed.

**2.1.2 Working Standards.** Working chemical standards may either be purchased through an approved vendor or prepared from stock standards. Working standards will be made by diluting neat or prepared stock standards. For standards made from neat solutions, the compound density or weight will be used in calculating the appropriate amount of compound and solvent to be combined. All working standards will be labeled with an identification code (see below), compound or mix name, and concentration. The associated logbook will contain the following information at a minimum:

- The Stock solution used to make the working standard, including either the information required for logging the stock solution or a reference to where that information can be found.
- Both a written description and calculation of how the working standard was prepared.

- The solvent(s) and associated lot number(s) used in preparing the standards.
- The final concentration of the working standard.
- The GC/MS code associated with the standard.
- Standard and stock solutions will be kept refrigerated at less than 10°C when not in use.
- The surrogate standard is made separately from the working standards.

**2.2 GC/MS Coding System.** The GC/MS coding system is used to trace all standards back to the vendor. All standard are required to have the appropriate code assigned when they are prepared and must be labeled accordingly. The GC/MS code will follow the format:

- FGCXXXXXXWWYZPPPP Where:  
XXXXXX is the month, day, and year that the standard was made,  
i.e., 041696 = April 16,1996.
- WW is the page in the logbook where the standard can be found, i.e., 01 to 99.
- Y is where the standard fell chronologically on the page, i.e., A through Z.
- Z is the logbook number where the standard can be found, i.e., 1 through 9.
- PPPP is the project identifier, i.e., USAF = United States Air Force, a short character identification of the project from 1 to 4 characters in length.

**2.3 Logbook Entries.** While the style and specific requirements for logbook entries will vary between operators and projects, certain information is required for all projects. At a minimum this will include:

- A table of contents listing what and where specific information is located.
- A listing of GC/MS run conditions and set points.
- A chemical standards preparation section containing the required standards information.
- A run log section containing at a minimum: sample identification, run number or computer file identification, sample amount (weight or volume), standard code for each standard used, amount of standard(s) used, an example calculation for any calculations performed, dilution factor, and a remarks column with any pertinent information (e.g., unusual sample color or odor, unusable blanks, failed standards, coelutions, reruns, etc.).
- An equipment maintenance section containing both routine and equipment malfunction maintenance (e.g., column replacement, electronic parts replacement, GC/MS repair, replacement, or cleaning, etc.)

## 3.0 TUNING

**3.1 TDGC/MS Tune.** The HP-5890 uses a standard autotune macro to tune the mass spectrometer. Three masses of the calibration compound (PFTBA) are selected: 69, 219, and 502. . The procedure is automatically implemented upon manual selection of the automatic tune feature of the instrument. For all 3 masses, starting with 69 amu, the MS system adjusts the mass, peak width and energy in that order until it achieves the desired values. The resolution is

set to unity with a *ca.* 10% valley definition; this is done by measuring the actual peak width and adjusting the peak width parameter accordingly. The GC/MS system will be tuned at the start of each day prior to analyzing samples. The tune is considered valid for each 24 hour period.

## 4.0 CALIBRATION.

**4.1 Multilevel Calibration.** In the initial multilevel calibration, a minimum of five levels (concentrations) of standards are analyzed. The standard concentrations are selected to cover the concentration range of contaminants expected (approximately 0.1 to 100 ppm). This includes a low concentration standard at or near the method detection limit (MDL). In addition, the upper level standard has to be within the working range of both the detector and the column.

**4.2 Daily Calibration.** After mobilizing the TDGC/MS unit to the field, the analyst must prepare calibration standards at a minimum of five concentration levels for each compound. The concentrations should correspond to the expected range of concentrations found in the "real-world" sample or the establishment of the GC/MS dynamic range.

**4.3 Internal Standard Calibration Procedure.** Prepare a solution that will contain at least one internal standard (Pyrene-d10 has been selected for the Hanscom project) using the procedures described in Sections 2.0 and 2.1. The internal standard concentration should be 50 ppb. Pyrene-d10 is selected as the internal standard because of its retention characteristics relative to PAHs and PCBs.

**4.4 Calibration Curve.** Inject calibration standards containing the internal standard onto the desorption tube and analyze using TDGC/MS. The internal standard concentration should be 50 ppb. Analyze a calibration sample at a concentration near but above the MDL. Repeat analysis one time for each of the five concentration levels to cover the linear range.

**4.5 Response Factors.** Repeat analysis one time for each concentration. Tabulate the area response of the characteristic ions against concentration for each compound and internal standard and calculate response factors (RF) for each compound using Equation 1:

$$RF = (A_X)(C_{IS})/(A_{IS})(C_X) \quad [1]$$

where,  $A_X$  = area of the standard target analyte ion current signal,  $C_{IS}$  = concentration of the internal standard,  $A_{IS}$  = area of the internal standard ion current signal, and

$C_X$  = concentration of the standard target analyte

If the RF value is constant (i.e., < 30% relative standard deviation, with no more than one third of the samples with > 30% RSD for quantitative GC/MS) over the dynamic range, the RF can be assumed to be invariant and the average from the RF value(s) can be used for quantitation. If the average RF values for any analytes fall outside of the 40% RSD window, the instrument must be checked for mass drift and the point or points skewing the curve must be performed again.

**4.6 Continuing Calibration.** The working calibration curve or RF must be verified each working day with a mid-level calibration standard. If all of the analyte RF's from the continuing

standard have respective %D's within the 30% and 40% requirements then analysis of samples may begin. If the response for 1/3 of the compounds varies from the initial calibration curve response factor by more than 40% then the test must be repeated using a fresh calibration standard at mid-level concentration. This is repeated until third failure, if the continuing calibration criteria are not achieved then a new calibration curve with a minimum of five concentration levels will be generated.

**4.7 Closing Calibration.** The working calibration curve or RF must be verified each working day with a mid-level calibration standard. If all of the analyte RF's from the continuing standard have respective %D's within the 30% and 40% requirements then analysis of samples may begin. If the response for 1/3 of the compounds varies from the initial calibration curve response factor by more than 40% then the test must be repeated using a fresh calibration standard at mid-level concentration. This is repeated until third failure, if the closing calibration is still not in control, then a new calibration curve must be generated and all samples analyzed during the previous calibration period must either be re-analyzed or flagged to indicate that the system was not within the QC requirements.

## 5.0 METHOD DETECTION LIMITS

**5.1 MDL Determination.** The MDLs are determined for each compound in soil prior to the analysis of samples. This is accomplished by analyzing seven replicate low concentration standards near the expected MDL. From these analysis a standard deviation is calculated and multiplied by 3.14 to establish the MDL. This correlates to a student's *t* of 99% for (n-1).

**5.1.1 Soil MDL.** Soil MDLs will be performed using a minimum of 2 grams of blank soil spiked with the target compounds at 1 to 10 ppm.

## 6.0 COMPOUND IDENTIFICATION

**6.1 Total Ion Current Mode.** Compounds will be identified using the total ion current mode (TIC). TIC's for the primary ion and at least two secondary ions for each compound of interest must be identified. The following criteria must be met to make a qualitative identification.

**6.1.1 Characteristic Ions.** The characteristic ions of each compound of interest must maximize within one scan of each other.

**6.1.2 Retention Time.** The retention time of the suspected analyte must fall within  $\pm$  30 seconds of the retention time of the actual target analyte as determined by the calibration data.

**6.1.3 Relative Peak Heights/Areas.** The relative peak heights/areas of the three characteristic ions in the TIC's must fall within  $\pm$  40% of the relative intensities of these ions according to the mass spectra obtained during calibration for targeted analytes or from a reference mass spectrum for non-targeted analytes.

**6.1.4 Structural Isomers.** Structural isomers that have very similar mass spectra and less than 30 seconds difference in retention time, can be explicitly identified only if the resolution between authentic isomers in a standard mixture is acceptable. Acceptable resolution is achieved if the baseline to valley height between the isomers is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

<u>Polycyclic Aromatic Hydrocarbons</u>	<u>Ions</u>
Naphthalene	128, 129, 127
Acenaphthylene	152, 151, 153
Acenaphthene	154, 153, 152, 151
Fluorene	166, 165, 167, 163
<sup>1</sup> Phenanthrene	178, 176, 179, 177
<sup>1</sup> Anthracene	178, 176, 179, 177
<sup>2</sup> Fluoranthene	202, 203, 200, 201
<sup>2</sup> Pyrene	202, 203, 200, 201
<sup>3</sup> Chrysene	228, 226, 229, 227
<sup>3</sup> Benzo(a)anthracene	228, 226, 229, 227
Benzo(a)pyrene	252, 250, 253, 251
<sup>4</sup> Benzo(b)fluoranthene	252, 250, 253, 251
<sup>4</sup> Benzo(k)fluoranthene	252, 250, 253, 251
<sup>5</sup> Dibenz(a,h)anthracene	278, 279
<sup>5</sup> Indeno(1,2,3-cd)pyrene	276, 277, 275, 274
Benzo(g,h,i)perylene	276, 277, 274
<sup>†</sup> Pyrene-d10	212, 211, 210
<sup>‡</sup> Octachloronaphthalene	402, 404, 406
<sup>†</sup> Internal Standard,	
<sup>‡</sup> Surrogate	

Note: Compounds with the same superscript number coelute.

## 7.0 CALCULATIONS

**7.1 Quantitation.** When a compound has been identified the quantitation of that compound should be based on the integrated abundance from the TIC of the primary ion. If the sample produces an interference for the primary ion then use a secondary characteristic ion to quantitate.

**7.1.1 Soil Samples.** The quantitation of an identified compound is based on the integrated area of the analyte's primary ion (100% relative abundance) extracted from the total ion current chromatogram.

Calculate the concentration of the analytes in soil/sediment sample by using the following equation:

$$\text{Concentration (ng/g)} = K(A_x)(C_{is})/(A_{is})(RF)(W_s)(D)$$

where K = dilution factor, W<sub>s</sub> = weight of the sample (g), and D = (100-% moisture in the sample)/100 if appropriate.

## 8.0 BLANKS

**8.1 PAHs and PCBs Blanks.** Prior to analysis of any calibration or actual site samples, a method blank analysis must be performed. A method blank is performed where the extraction solvent, apparatus, and thermal desorption tube are checked for background contamination. A blank extraction procedure is performed and an aliquot of the resulting extract solvent is placed on the thermal desorption tube and allowed to volatilize. The residue is then thermally desorbed off of the tube by heating the thermal desorption port at 280°C, and analysis is performed as discussed below. The solvent residue is thus analyzed using the method GC temperature program with MS detection for the presence/absence of background contaminants.

**8.2 Corrective Action.** If background contamination is found, a stepwise process of elimination will be performed from the thermal desorption tube back to the initial extraction solvent to isolate and eliminate the source of contamination. Prior to any analyses (calibration or site samples) the system must be found to be free of any outside sources of contamination. If the internal standard (e.g., pyrene-d<sub>10</sub>) is suspected to be contaminated, this procedure must be repeated with the addition of the internal standard for thermal desorption.

**8.3 Interferences.** Contamination by carry-over can occur whenever low-level samples are analyzed after high-level samples. This can be avoided by baking out the thermal desorption port and the capillary column at 280° and 240° respectively, for a few minutes after high-level samples are analyzed. The thermal desorption tube should be cleaned with analyte-free solvent after each analysis. The instrument will be monitored after every sample analysis, by targeting specific hydrocarbon ions, to ensure background currents reach normal levels. The use of high purity (HPLC grade) reagents will help to minimize interference problems.

## 9.0 SAMPLE PREPARATION

**9.1 Sample Preparation** The soil sample is thoroughly homogenized in the sample container and a sub-sample (2.0g +/- 0.2g) is weighed and placed in a 8-mL sample vial with a Teflon lined screw cap. To this vial is added the surrogate compound as required. The surrogate will be added at a concentration in the mid-range of the calibration (50-100 ppm final concentration). Approximately 2g of anhydrous sodium sulfate are added and the sample is thoroughly mixed with a Teflon coated spatula to form a free-flowing mixture. 2.0-mL methylene chloride is then added to the sample. This solution is then hand shaken for 2 minutes, allowed to settle briefly (< 30 seconds or use a centrifuge). The extract is then transferred into a 2-mL glass sample vial using a disposable glass Pasteur pipette. The extract may be used directly for TDGC/MS analysis. Batch lots of these apparatus must be analyzed through the method blank and found to be free of interfering contaminants.

**9.2 Sample Introduction.** An aliquot of the extract (50 µL or method detection limit study volume) is injected onto a thermal desorption tube along with 2.5 µL of 20 ng/µL internal standard solution previously prepared. Internal standard concentration will vary dependent upon individual instrument sensitivity and levels of monitored analytes expected to be found at the sampling

location, however, 50 ng is generally a sufficient quantity. After the solvent has vaporized, the residues of the sample extract and the internal standard are then thermally desorbed into the capillary column of the TDGC at a temperature of 280°C.

## 10 QUALITY CONTROL

**10.1 Quality Control.** The following procedures will be implemented by the field chemist to insure standardization of the operating procedures:

**10.1.1 Review.** The field chemist will review each chromatogram before analyzing the next sample. The review will include the comparison of target compound retention times to calibration standards, and the evaluation of carryover potential.

**10.1.2 Soil Surrogate Recoveries.** Octochloronaphthalene will be the surrogate for the Hanscom project. Surrogate recoveries for soil samples must be greater than 30 percent and less than 200 percent. Soil samples with surrogate recoveries of less than 30 percent must be reanalyzed to confirm matrix interferences. Soil samples with recoveries greater than 200 percent will be noted in the log book. If the surrogate recovery is less than 30 percent for the soil sample then the sample will be reanalyzed. If the surrogate fails the second analysis the results will be reported and the recovery noted in the logbook.

**10.1.3 Duplicates.** Duplicate analysis will be performed at a rate of every twenty samples following the first five samples analyzed. When possible, the duplicate will be chosen which was found to contain target analyte. In such cases, it is preferable (time permitting) to perform triplicate analysis and establish measurement precision criteria. Duplicate analysis measurements must result in < 60% RPD for samples with concentrations higher than 5x PQL. The measurements must result in < 100% RPD for the samples with concentrations in the range from 1x to 5x PQL. Triplicate analysis measurements must result in < 60% RSD for samples with concentrations higher than 5x PQL. The measurements must result in < 100% RSD for the samples with concentrations in the range from 1x to 5x PQL.. The RPD is measured as:

$$\text{RPD} = (\delta/y) \times 100$$

where,

$\delta$  = the absolute value of the difference between the duplicate measurements.

$y$  = the mean of the two measurements.

If duplicate analysis criteria fails, the system will be checked for mass alignment, sensitivity, and retuned prior to re-homogenization and re-analysis of the sample.

**10.1.4 Internal Standard.** The internal standard(s) will be monitored for each analysis. The area count for the internal standard must fall within -50% to +150% of the average internal standard area count established for the initial calibration curve. If the internal standard area count falls outside this range, the system will be checked for mass alignment, sensitivity, and retuned if necessary prior to re-analysis. If the internal standard area count falls outside of the criteria upon re-analysis, a new three point calibration curve will be established with new internal standard area count limits.

## 11 REPORTING

**11.0 Reporting.** Data from all sample analyses and relevant calibration and blank analyses will be documented in the project GCMS run logbook. A quality control summary may be generated at the completion of the project and will include some or all of the following as required: initial calibrations, continuing calibrations, surrogate recoveries, method blanks, dilutions, reanalyzes, observations of the field chemist, problems and fixes, unknown peaks, raw data, etc..

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## **TUFTS UNIVERSITY STANDARD OPERATING PROCEDURE**

### **TUFTS UNIVERSITY SITE OPERATION PLAN FOR FIELD TRANSPORTABLE ICP-AES METHOD FOR ANALYSIS OF PRIORITY INORGANIC POLLUTANTS IN SOIL AND WATER MATRICES**

#### **1.0 SCOPE AND APPLICATION**

1.1 A quantitative method based upon the contract laboratory program using a specially modified ICP-AES built to withstand transport to a field environment. The instrument in all other respects performs exactly like its laboratory counterpart.

#### **2.0 SUMMARY OF METHOD**

2.1 Soil, sediment and water samples are digested using microwave acid digestion followed by filtration and dilution. The filtrate is then nebulized into the ICP-AES via an autosampler for analysis.

#### **3.0 INTERFERENCES**

3.1 Background contamination of trace metals is negligible when utilizing microwave acid digestion vessels due to the chemically inert nature of the Teflon™ material. Post digestion cleanup of vessels requires only a ASTM Type I rinse until all visual particles have been removed.

3.2 Contaminants can be minimized during filtration by using a Teflon™ column assembly utilizing positive air pressure to push the filtrate through a disposable 30-60 micron Teflon™ membrane supported upon a porous polypropylene frit. Filtrates are collected in HDPE containers.

3.3 Contaminants during ICP-AES can be introduced by memory effect in which metals adhere to the walls of the pumping system, nebulization chamber and nebulization device. This can be detected by instrument scans of blanks and minimized with properly set rinse out times between sample runs.

3.4 Interelement effects due to matrix constituents will be corrected by interelement and background check standards obtained from an independent source if necessary. The PS-1000M (Leeman Laboratories) modified at Tufts University has a high resolution monochromator which enables unambiguous detection of most analytes at specific wavelengths. Background correction points are typically set on-site after test samples have been scanned against the standard correction library.

## 4.0 APPARATUS AND MATERIALS

### 4.1 CEM MDS-2000 (CEM Corp. Matthews, NC)

4.1.1 This microwave system allows solid and liquid samples to be digested in PFA lined Teflon™ bombs with working pressures up to 200psi and a rupture disc protection at 220 psi. There is one control vessel per twelve which has both pressure and temperature sensor capabilities. The oven operates at 110-120V 20A 60Hz with 630 Watts of microwave power at a frequency of 2450Mhz. The instrument has a built-in LCD panel for programming both temperature and pressure controlled methods. After a digestion the PFA liners are cleaned with ASTM Type I water.

#### 4.1.2 Sample Digestion Tools and Equipment

- Microwave unit
- (24) advanced composite vessels with (2) racks
- (6) extra PFA liners
- PFA rupture discs
- Analytical balance  $250\text{g} \pm 0.1\text{mg}$
- (2) sensor head vessels
- 3-prong outlet
- Exhaust port
- (6) PFA coated thermowell sleeves
- (2) Fiber-optic temperature probes
- 1L Teflon™ Bottle
- An adjustable volume bottle-top dispenser (Teflon™ lined)
- Weighing paper
- (4) Spatulas
- (2) Concentrated acid bottle-top dispensers (For waters analysis only)

#### 4.1.3 Filtration Apparatus

- Zitex porous Teflon™ membrane 30-60 micron (sheets)
- Air cylinder / regulator
- PFA columns
- Gas manifold
- Hole boring tool
- 60ml HDPE sample containers (1 per sample)
- 1000ml Teflon™ Bottle with Type I water
- An adjustable volume bottle-top dispenser (Teflon™ lined)

### 4.2 The PS1000 M Inductively Coupled Plasma/Atomic Emission Spectroscopy Echelle Sequential Spectrometer (Leeman Labs, Lowell MA) was modified at Tufts University.

4.2.1 This instrument uses the hildebrand nebulizer to introduce samples into the plasma. It features an autosampler which will be used in conjunction with macros within the instrument software to allow for continuous utilization.

#### 4.2.2 Lab Bench Requirements

Spectrometer	Power Supply
Width: 60"	Width: 20"
Depth: 35"	Depth: 35"
Height: 40"	Height: 14"
Weight: 375lb. (170kg)	Weight: 200lb (91kg)

The instrument will not be located near ventilation ducts from heat or air conditioning in order to ensure temperature stability.

#### 4.2.3 Environmental Conditions

Temperature range: 15-30°C (60-86°F)

Temperature variation: Should not exceed 2°C (3.6°F) per hour and 10°C (18°F) during the work day. Instrument modifications have been done to increase temperature drift tolerances to ±20 °F.

Relative humidity: 20-80% non-condensing

#### 4.2.4 Electrical Power

One 190-230 V, 30 Amp, 50/60Hz grounded single phase line connected to circuit breaker with Hubbell Twist-Lock (Part # 2620A) receptacle.

Two 115 V, 15 Amp, 60 Hz or 220 V, 10 Amp, 50Hz double-plug outlets for Spectrometer.

Three regular three prong outlets.

#### 4.2.5 ICP Exhaust

10-12" stainless steel or corrosion resistant exhaust 42-45" above lab bench surface.

#### 4.2.6 Argon Gas Supply

One Liquid Ar Dewar in use and one more as a backup. (purified grade)

#### 4.2.7 Tools and Equipment

- (2) Hildebrand Grid Nebulizers in reserve
- (2) torches in reserve at all times
- Autosampler
- Certified Standards and Check Solutions are Plasma-Pure (Leeman Labs, Lowell, MA)
- Independent standards (multi-element)
- Polymeric fine tip transfer pipets

- Teflon™ bottles for standards
- Amber HDPE bottles for Ag containing solutions
- Carboy filled with Type I water
- HDPE test tubes with caps
- 16mm test tube racks
- Teflon™ wash bottles
- (2) packages sample and waste tubing
- Consumables kit for routine maintenance
- Tool kit designed for instrument
- 1L volumetric flask
- 1L Teflon™ bottle for reagent blank
- 1L HDPE bottle for waste
- Digital thermometer

## 5.0 REAGENTS

5.1 Hydrochloric and nitric acid for digestion and standard preparation are of trace metals grade quality. Water is ASTM Type I 18 MegaOhm.

5.2 Preparation Standards will be purchased from the same commercial source with the exception of the Laboratory Control Standard.

5.2.1 Certified Standard single-element and multi-element solutions of all metals traceable to NIST.

5.2.2 Compatible multi-element standard solutions will be prepared as necessary from their stock solutions by gravimetric dilution on an analytical balance to the nearest 0.1mg. The sample acid concentration will be used as the concentration of the diluent.

5.2.3 An initial calibration verification standard will be run to check if the calibration is acceptable.

5.2.4 An independent multi-element standard from a different source than used in the calibration standards will be run for QA/QC purposes and diluted to the appropriate level when necessary.

5.2.5 A CLP interelement and background correction standard will be used.

5.2.6 Spike standards will be used if necessary.

5.2.7 A Laboratory control soil sample will be run, PriorityPoluntnT™ (ERA, Averada, CO).

5.2.8 A laboratory control water sample will be run, WasteWatR™ (ERA, Averada, CO).

## **6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING**

6.1 Most samples will be analyzed upon receipt and when appropriate will be preserved by a suitable technique.

## **7.0 ICP-AES OPERATION AND MAINTENANCE**

7.1 The instrument will be allowed at least 1.5 hours for warm-up of torch and sample introduction apparatus. During the initial warm-up period the source mirror will be peaked on the Mn 257.610 nm line. This operation determines nebulizer performance and assures optimal alignment of the plasma and monochromator. Once a good MnY profile is obtained the operator will peak all analytical wavelengths. The following parameters made need to be adjusted by the operator:

Power	Pump Rate
Nebulization pressure	Integration time
Coolant Flow	Sample uptake time
Auxiliary Flow	Rinse out time
Elemental wavelength	Background correction point(s)

### 7.1.1 Daily Maintenance may require

- a) Changing pump tubings...typically every 3-4 day
- b) Emptying of waste container
- c) Sample introduction disassembly...
  - 1) to replace O-rings...typically twice per month
  - 2) check nebulizer spray visually and audibly
  - 3) cleaning of torch....only when needed
  - 4) cleaning of spray chamber...only when needed

7.2 Maintain an Instrument Maintenance Log Book recording any changes such as:

- 7.2.1 Changing sample introduction components
- 7.2.2 Changing Argon supplies
- 7.2.3 Any preventive maintenance performed
- 7.2.4 Any significant changes to the instruments environment
  - a) HVAC difficulties
  - b) new equipment coming on line
  - c) power interruptions
  - d) temperature variance

7.3 Weekly Maintenance

- 7.3.1 Change pump tubing and O-rings

- 7.3.2 Clean and lubricate the autosampler
- 7.3.3 Check RF contact strip for corrosion and looseness
- 7.3.4 Check water level in water recirculator
- 7.3.5 Check air filters on power supply and spectrometer, clean as necessary

#### 7.4 Monthly

- 7.4.1 Change O-rings
- 7.4.2 Clean filters on power supply and spectrometer
- 7.4.3 Drain water recirculator and refill with **FRESH DI WATER**

#### 7.5 Semiannual

- 7.5.1 Clean water recirculator
  - a) Drain completely
  - b) Wipe reservoir clean
  - c) Refill with **FRESH DI WATER**
- 7.5.2 Acid rinse the cooling water lines
  - a) Disconnect lines at the recirculator
    - 1) Drain water from instrument
  - b) Fill water lines with 5% HCL 5% HNO<sub>3</sub>
    - 1) Acid solution should **never** enter the recirculator
    - 2) Wait **5 minutes**
  - c) Flush lines with at least 20 liters of DI water
  - d) Reconnect the recirculator
    - 1) Fill with **FRESH DI WATER**
    - 2) Use of algaecides is not recommended
- 7.5.3 Replace inline Argon filter

### 8.0 PROCEDURE

#### 8.1 Soil Sample Preparation

- 8.1.1 Samples will be logged into a Sample Preparation Logbook.
- 8.1.2 1.00 ±0.001 grams of soil will be weighed by analytical balance on weigh paper and transferred to a PFA liner.
- 8.1.3 Two microwave acid digestion matrices are available depending on the elements of interest. The 50% nitric digestion is based upon EPA method 3051 and recovers all target analyte metals except Ag and Sb. Complete recovery of these elements can be accomplished using 50% 3:2 HNO<sub>3</sub>:HCl. The digestion parameters are shown in the following table:

Matrix I.D.*	1	2
Acid	50% HNO <sub>3</sub>	50% 3:2 HNO <sub>3</sub> :HCl
volume (ml)	20	20

sample weight (g)	1.00	1.00	
# of vessels	12	12	
stages	(1) (2)	(1) (2)	
power %	100 100	100 100	
temperature (°C)	130 175	120 165	
pressure (psi)	120 190	120 200	
time allotted (min)	20.0 20.0	10.0 20.0	
ramp time (min)	----	----	----
hold (min)	5.0 5.0	5.0 5.0	

8.1.4 Once samples have cooled the 20ml digestate is transferred by Teflon™ funnel to a filtration column and 10-20 psi of air pressure applied once the gas assembly has been sealed. The filtrate is dilute to 25% total acid volume with 20ml Type I water from a dispenser and the tared weight is recorded in the sample preparation logbook.

8.1.5 Filtration columns are disassembled and thoroughly rinsed with Type I water and then a new membrane is loaded.

## 8.2 Water Sample Preparation

8.2.1 Samples will be logged into Sample Preparation Logbook.

8.2.2  $15.00 \pm 0.001$  grams of water will be directly weighed into a PFA liner.

8.2.3 Two microwave digestion matrices are available as indicated in *Section 8.1.3*. However, the only change shall be that the acid will be volumetrically delivered via a bottle-top dispenser in concentrated form. Matrix 1 will be 5ml concentrated nitric acid and Matrix 2 shall be 3ml concentrated nitric and 2ml hydrochloric acid. The same time parameters will be employed, but the *time allotted* can be increased if the correct temperature profile is not obtained.

8.2.4 When the samples have cooled the analyst will determine if any suspended particulates are present. If not, then sample will be transferred directly to sample bottles with the tared weight recorded into the sample preparation logbook. If so, then they shall be filtered through Teflon™ columns. The air pressure will be reduced to 2-5 psi.

8.3 When the Operator determines that the instrument has adequately warmed up and is stable the following actions are taken:

8.3.1 Peak in all metals and set integration time. Integration time will be dependent upon matrix interferences and sensitivity requirements.

8.3.2 Scan a peaking standard as well as a method blank to select best background correction point(s). Follow this by scanning the test sample matrix, adjust accordingly.

8.3.3 Run calibration standards manually.

8.3.4 The calibration curve for each metal is graphically displayed and the operator determines if the calibration meets QC/QA criteria. The operator must accept each calibration curve before proceeding to sample analysis. If an element fails QC/QA requirements then the element is scanned and repeated. After running the standards for this metal if it still does not meet QC/QA requirements then instrument parameters need to be adjusted by the operator. As a last resort new standards should be prepared.

8.3.5 If the calibration curves pass QC/QA criteria then samples can be analyzed by transferring samples to HDPE test tubes and programming a autosampler rack file and engaging the autosampler macro. Additionally all solutions run are entered into a sample sequence logbook. All actions taken by the instrument are physically recorded on a dot matrix printer and assigned a unique sequence number.

## **9.0 QUALITY CONTROL/QUALITY ASSURANCE**

9.1 QC/QA will follow, for the most part, CLP SOW ILM01.0 which is summarized in Appendix 12.1

## **10.0 INSTRUMENT DETECTION LIMITS**

10.1 Note that method detection limits will be sample dependent and vary according to changes in the sample matrix. The Instrument Detection Limits and Limit of Quantitation values in the table below are typical for the PS-1000M instrument.

Analyte	PS 1000 IDL (ug/kg) <sup>1</sup>	Matrix 1 LOQ (mg/kg) <sup>2</sup>	Matrix 2 LOQ (mg/kg) <sup>2</sup>
Aluminum	37	5	5
Antimony	46	6	6
Arsenic	51	7	7
Barium	1.1	0.2	0.2
Beryllium	0.20	0.02	0.02
Cadmium	2	0.22	0.22
Calcium	8.0	1.1	1.1
Chromium	8.0	1.0	1.0
Cobalt	10	1.3	1.3
Copper	4.0	0.55	0.55
Iron	3.0	0.4	0.4
Lead	40	5.0	5.0
Magnesium	57	7.5	7.5
Manganese	1.0	0.07	0.07
Nickel	10	1.25	1.25
Potassium	550	73	73
Selenium	123	16	16
Silver	5.1	0.7	0.7
Sodium	45	6	6
Thallium	78	10.5	10.5
Vanadium	3.0	0.4	0.4
Zinc	7.4	1	1

1 IDL determined using EPA 40 CFR Ch. I Pt. 136, App B.

2 Limit of Quantitation values based upon 1.00g soil sample and calculated by multiplying (IDL) x (sample dilution factor) x (3).

## 11.0 DATA REPORTING

11.1 Field data will be reported in a format which maximizes transfer to site mapping technologies. The final report will include full QA/QC data in publication format.

## 12.0 APPENDIX

### 12.1 QC/QA Requirements for ICP-AES:

<b>Requirement</b>	<b>Superfund Hazardous Waste Analysis CLP SOW ILM01.0</b>
<b>Initial Calibration Frequency</b>	1 standard and a blank Daily
<b>Calibration Verification Frequency</b> Criteria	Mid-range standard Beginning, end, and every 10 samples or every 2 hrs 80-120% recovery
<b>Other Standards</b> Frequency Criteria	Standard at 3x CRDL or IDL Beginning and end of each run or 2 every 8 hrs EPA QC limits
<b>Interference Check Sample</b> Frequency Criteria	EPA Solution A and AB Beginning of each day 80-120% recovery
<b>Calibration Blanks</b> Frequency Criteria	diluent matrix Beginning, end, and 10% of samples or every 2 hrs All analytes $\leq$ CRDL
<b>Preparation Blank</b> Frequency Criteria	run through sample treatment process 1 per SDG* or digestion batch All analytes $\leq$ CRDL
<b>QC Check Sample / LCS</b> Frequency Criteria	SRM or site sample 1 per SDG or digestion batch for each matrix 80-120% recovery
<b>Triplicate Samples</b> Frequency Criteria	10% or 1 per SDG per matrix per level (predigestion) $\leq$ 20% RPD for values $\geq$ 5x CRDL

\* Sample Delivery Group

### Corrective Actions

**Initial Calibration Verification (ICV):** Terminate analysis, correct problem, recalibrate, reverify standards concentrations. Examine the RSD's of the reps. If they are excessively high it might indicate a sample introduction problem. Recalibrate. If RSD's of reps still high adjust rinse and uptake time.

**Continuing Calibration Verification(CCV):** Same as ICV, all samples to last compliant CCV must be reanalyzed upon correcting problem.

**Other Standards:** Verify linearity near CRDL or IDL whichever is greater. Acceptance criteria have not been determined by EPA yet. Just report value (All analyte wavelengths except for Al, Ba, Ca, Fe, Mg, Na, K).

**Interference Check Sample (ICS):** Terminate analysis , correct problem, recalibrate. Two solutions A (interferents) and AB (analytes and interferents). Run A followed by AB.

**Calibration Blank:** Terminate analysis, correct problem, recalibrate, and reanalyze last 10 samples after last compliant CB.

**Preparation Blank:** Lowest concentration of analyte must be 10x the concentration of the PB. If sample falls between CRDL and 10x then those samples must be redigested and reanalyzed for the analytes.

**QC/ LCS (Laboratory Control Sample):** Terminate analysis, correct problem. Samples associated with that LCS redigested and reanalyzed.

**Matrix Spike Samples:** Indicate by flagging those samples in the data report. Except where sample concentration exceeds spike concentration by four.

**Duplicate Samples:** If the data falls outside the control limits it must be flagged when reported.

## **TUFTS UNIVERSITY STANDARD OPERATING PROCEDURE**

### **TUFTS UNIVERSITY SITE OPERATION PLAN FOR FIELD TRANSPORTABLE EDXRF METHOD FOR ANALYSIS OF PRIORITY INORGANIC POLLUTANTS IN SOIL**

#### **1.0 SCOPE AND APPLICATION**

1.1 A quantitative and semi-quantitative method for analyzing most metals on the priority pollutant target analyte list using a bench top instrument platform.

#### **2.0 SUMMARY OF METHOD**

2.1 Soil samples are directly transferred into a 32mm XRF cell and covered with prolene film. The sample is irradiated with x-rays resulting in fluorescent emission which is detected by a semi-conducting crystal. Energy resolution is used to separate the signal for each element and produce an intensity response. Software processes the count rates for each element via fundamentals parameters.

#### **3.0 INTERFERENCES**

3.1 When element energy peaks are not resolved the software uses predetermined ratios to calculate the relative contribution due to each element. Interferences are minimized by subjecting a representative soil sample to a multistage excitation procedure which optimizes the resolution between each elemental peak and provides the maximum intensity response.

#### **4.0 APPARATUS AND MATERIALS**

4.1 QuanX XRF (TN Spectrace, Sunnyvale, CA)

4.1.1 The Spectrace QuanX is a compact energy dispersive x-ray fluorescence (EDXRF) system. The analyzer uses an x-ray tube excitation source and a solid state detector to provide spectroscopic analysis of elements ranging from sodium to uranium in atomic number. Instrument control and data analysis are performed by a personal computer that is connected to the system. Fundamental parameters (Section 8.2) are determined and used by the computer to calculate element concentrations. No further calculations (e.g. sample moisture or sample size) are necessary. The system requires regular A/C line voltage and current. The use of a

vacuum pump (Alcatel Pascal Model 2010, Kurt J. Lesker Co., PA) is necessary for elements less than eighteen in atomic number.

#### 4.1.2 Sample Preparation

- 32mm double open-ended (Chemplex, Tuckahoe, NY)
- Microporous Film (Chemplex)
- Prolene x-ray film 4.0 microns (Chemplex)
- (4) Spatulas

### 5.0 REAGENTS

5.1 National Institute for Standards and Testing (NIST) soil SRMs 2704, 2709, 2710.

5.2 Water is ASTM Type I 18 MegaOhm.

### 6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Samples can be directly analyzed or sealed in appropriate jars and stored in a refrigerator for an extended period of time.

### 7.0 EDXRF OPERATION AND MAINTENANCE

7.1 The instrument will be left on at all times. The solid state detector is thermoelectrically cooled and must remain on to achieve the best results.

7.1.1 Daily Maintenance entails running a test spectrum of a copper disc referred to as an energy calibration to assign the proper position of the  $K_{\alpha}$  and  $K_{\beta}$  for copper which are 8.047 and 8.904 keV respectively.

### PROCEDURE

#### 8.1 Soil Sample Preparation

8.1.1 Samples will be logged into a Sample Preparation Logbook.

8.1.2 One side of the XRF cell is covered with the microporous film, flipped over and soil is placed into the cell to a height of approximately  $\frac{3}{4}$  of the cup volume. The prolene film is then stretched over the opening with a collar and the cell is shaken and place prolene film side down on a clean surface.

## 8.2 Instrument

8.2.1 NIST SRMs 2704, 2709, 2710 are loaded into the instrument and analyzed for a total of 200 lifetime seconds for each step in the analysis. When the instrument is operated for 200 lifetime seconds the data is essentially quantitative whereas 120 seconds can be employed for a semi-quantitative screening of soil samples. The XRF analysis parameters with their corresponding elements are provided below.

	Step 1	Step 2	Step 3	Step 4
Elements	Al,Si,S	K,Ca,Ti,V,Cr,Mn	Fe,Ni,Cu,Zn,Sr,Zr,Pb	Cd,Ba,Ag
Tube Voltage (kV)	6	12	30	50
Tube Current (mA)	0.24	0.34	0.26	0.40
Filter	none	Al	Pd thick	Cu thick
Range (kV)	1-10	1-10	1-20	1-40
Atmosphere	vacuum	vacuum	air	air

8.2.2 Fundamental parameters is a complicated mathematical algorithm which characterizes the emission response of individual elements from a homogenous, infinitely thick sample surface. The software calculates pure element count rates (signal response) for each element in the certified reference standard. Soil sample concentrations are derived by comparing the pure element count rates of the sample versus the standard for each element.

## 10.0 INSTRUMENT DETECTION LIMITS

10.1 Since EDXRF is a surface technique the concentration value reflects the total amount of an element in the sample. The SRM certified values are produced by total dissolution of the soil matrix.

Analyte	Lowest Limit of Detection** (mg/kg)
Aluminum	500
Barium	105
Cadmium	2
Calcium	100
Chromium	21
Cobalt	15
Copper	10
Iron	15
Lead	8
Manganese	22
Nickel	15
Potassium	135
Silicon*	200
Silver	5
Strontium*	8
Sulfur*	90
Titanium*	24
Vanadium	20
Zinc	6

\*not listed in target inorganic list \*\*200 seconds livetime

## 11.0 DATA REPORTING

11.1 Concentration data is a direct readout from the instrument, with no further calculations needed. Data will be reported for those elements which can be analyzed by XRF and appear in the ICP-OES target list of analytes. The methodology will be optimized to provide maximum detection of both Cd and Pb. Those elements which are insensitive to excitation or whose energy lines are outside the energy range of the detector include Sb, As, Be, Mg, Na, and Tl.

## 12.0 APPENDIX

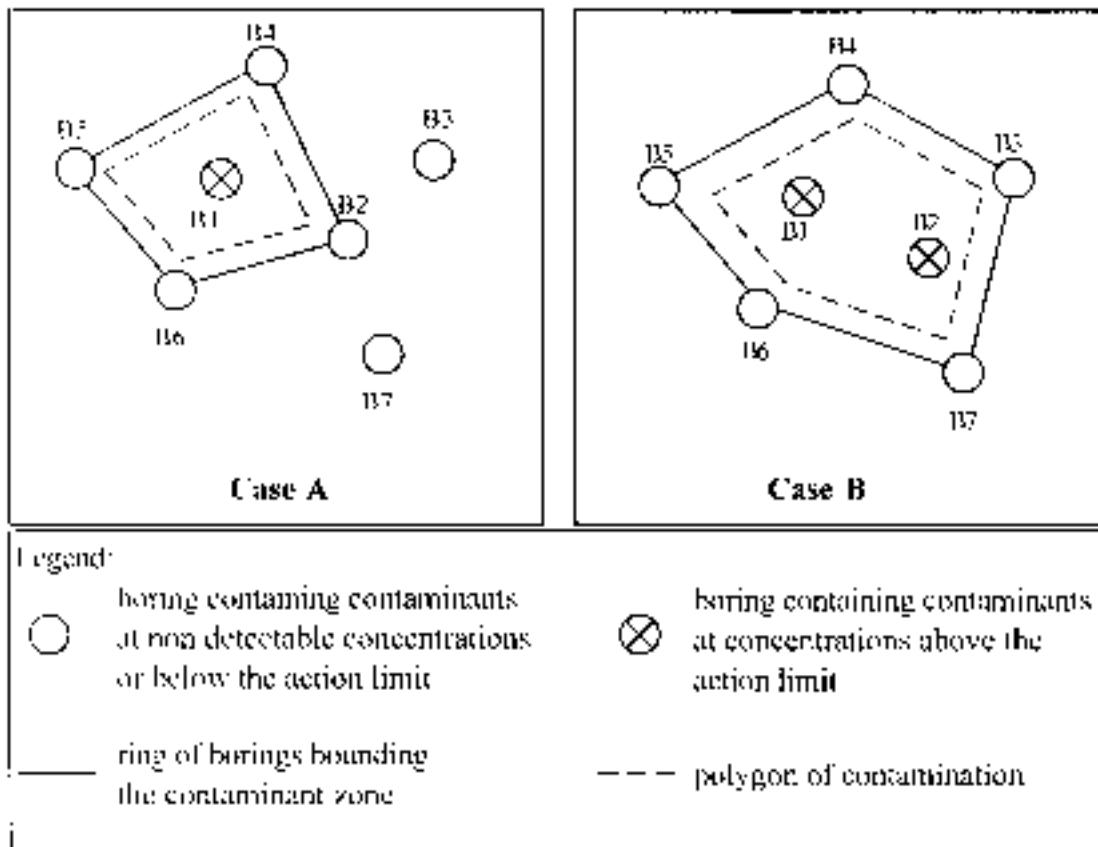
12.1 There are no established QA/QC procedures or criteria for this method. A soil standard obtained from Environmental Research Associates (Arvada, CO) will be run every 20 samples to track instrument performance.

## **Appendix IV**

**This section illustrates the volume estimate calculation for Sites 1, 2, and 3.**

## Volume Estimate Calculations

Illustrated below are two hypothetical volume calculations used as examples to explain the volume estimate calculations made for Sites 1, 2, and 3. Figure 1 shows the same seven borings, with one (Case A) and two (Case B) contaminated borings, respectively. The same method is used to estimate soil contaminant volumes.



**Figure 1. The Two Cases Considered for Volume Estimation**

For example, in Case A the following data is obtained for boring B1 (the contaminated Boring):

Screening Depth		Quantitative Depth	
Value		Value	
0-5 ft	ND	2-4 ft	ND
6-12 ft	Hit	6-8 ft	3-10DAF
12-15ft	ND	10-12 ft	10-10DAF
		13-15 ft	ND

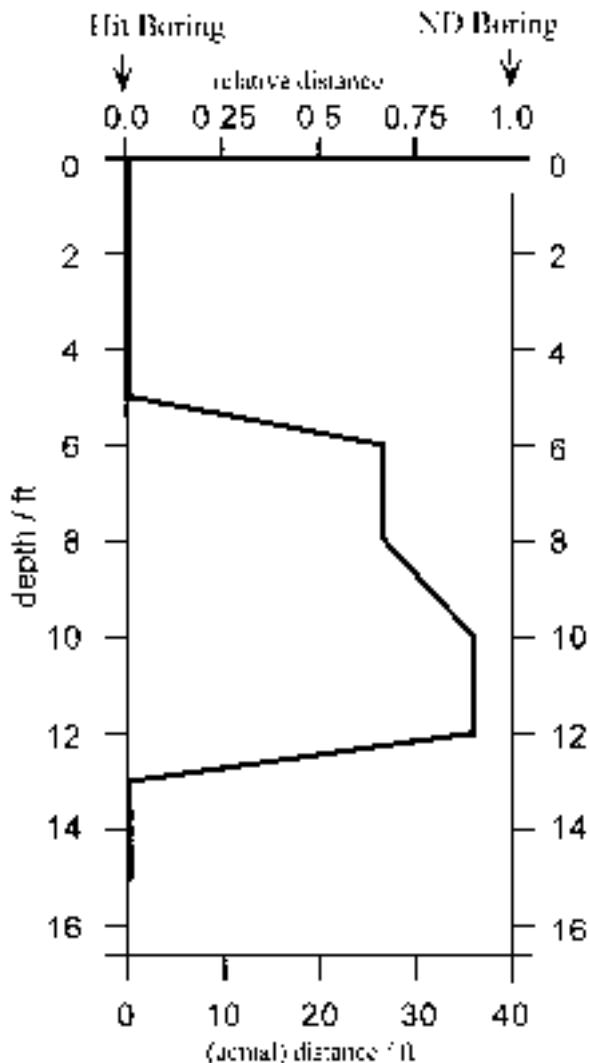
Note that screening data was produced every 1-ft during the HAFB investigation. The data indicates contamination between 6 and 12-ft, with quantitative data confirming this at the intervals shown in the table. This describes the contamination profile in the vertical direction for boring B1.

The horizontal contamination profile is calculated based on a linear interpolation between B1 and its nearest neighbor borings (2, 4, 5, and 6) where analyses indicate concentrations at or below the action level (designated as ND).

For example, the horizontal profile is shown in Figure 2 for the B1-B2 pair. Boring B2 is on the right and boring B1 on the left, with the distance between them 40-ft. The 6-ft to 8-ft interval is estimated separately from the 10-ft to 12-ft interval, with contaminant distances between them linearly estimated as well. Consistent with this calculation is the depth estimate from 5-ft to 6-ft and 12-ft to 13-ft. The process is repeated for each contaminant/ND boring pair (B1/B2, B1/B4, B1/B5, B1/B6). A 3-dimensional polygon depicting site contamination is obtained, which results in the total volume estimate for the site.

A more complicated situation occurs when an adjacent boring is also contaminated, see Case B. The first step in calculating the total volume estimate is to determine which boring pairs bound the site. For example, B1 is bound by B4, B5, and B6, while B2 is bound by B4, B3, B7, and B6. Based on the concentration data produced at each boring, the calculation process introduced in Case A can now be used to calculate the total site contamination volume for Case B. Note that this process is used irrespective of whether the same contamination profile exists at each boring with respect to depth. For example B1 may be contaminated between 6-ft and 12-ft while B2 may be contaminated between 6-ft and 15-ft.

At Hanscom Air Force Base, Site 3 was calculated as described in Case A, with four different contaminated borings used to estimate the total site volume ( $66,000\text{-ft}^3$ ). Site 1 contained two adjacent borings whose contaminant profile was consistent with depth. Case B was used to calculate the total volume estimate ( $28,000\text{-ft}^3$ ). Site 2 contained seven contaminated borings that were interconnected at various depths, a more complicated example of Case B. Total estimated soil contamination was calculated to be  $243,000\text{-ft}^3$ . Table 1 lists the contaminated and ND borings for each site, see Figures 7 to 9 in the body of the report for locations. Also tabulated are the calculated horizontal areas of contamination as a function of depth for each site.



**Figure 2. Calculated Vertical Profile of the Extent of Contamination**

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## **Appendix V**

**The following pages include all data generated as part of the HAFB field investigation.**

The following data was reported without data flags to reduce paper volume. The data was flagged to identify compound measured in blank above MDL, B; compound estimate above highest point in calibration curve, E; and compound measured between MDL and RL, J. A full data package can be obtained upon request by contacting Albert Robbat (Tufts University) or Nora Conlon (EPA Region I).

Although sample preparation and analyses were performed in separate sections of the mobile laboratory, site samples became contaminated with methylene chloride during the semivolatile sample preparation procedure. Methylene chloride, analyzed as part of the original HAFB target compound list, was taken out of the data set.

Organics Analysis by Field Gas Chromatography/Mass Spectrometry

## Organic Compound Analysis for the Hanscom Air Force Base ETI Project

Sample ID	S1 B01-A (02-04)	S1 B01-A (02-04) FD#1	S1 B01-A (02-04) FD#2	S1 B01-A (02-04) FD#3	S1 B01-A (06-08)	S1 B01-A (09-11) R1	S1 B01-A (09-11) R2
<b>Volatile Organics</b>							
1,1,1-Trichloroethane	<8.	<9.	<9.	N/A	<9.	<9.	41
1,1-Dichloroethane	<6.	<6.	<6.		<7.	<7.	<7.
1,1-Dichloroethene	<3.	<3.	<3.		<3.	<3.	20
1,2-Dichloroethane	<14.	<14.	<14.		<14.	<15.	<15.
Benzene	<3.	4	5		4	<3.	<3.
Carbon Tetrachloride	<4.	<4.	<4.		<4.	<4.	<4.
Chlorobenzene	<8.	<9.	<9.		<9.	<9.	<9.
Chloroform	<8.	<9.	<9.		<9.	<9.	<9.
cis-1,2-Dichloroethene	<5.	<5.	<5.		<6.	<6.	<6.
Ethylbenzene	<6.	<6.	<6.		<7.	61	39
m/p-Xylene	<17.	<17.	<17.		<18.	280	150
Methylene Chloride	67	66	64		65	55	41
o-Xylene	5	<3.	<3.		<3.	69	81
Styrene	<6.	<6.	<6.		<7.	<7.	7
Tetrachloroethene	<6.	<6.	<6.		<7.	<7.	<7.
Toluene	<10	<11.	<11.		<11.	<11.	<11.
trans-1,2-Dichloroethene	<6.	<6.	<6.		<7.	<7.	12
Trichloroethene	<19.	<19.	<19.		<20.	<20.	<20.
Vinyl Chloride	<34	<35.	<35.		<37.	<37.	<37.
<b>Semi-Volatile Organics</b>							
Acenaphthene	<42	<85	<85	<85	<44	<45	N/A
Acenaphthylene	<63	<130	<130	<130	<67	<67	
Anthracene/Phenanthrene	<136	<280	<280	<280	<144	<145	
Benzo(a)pyrene	<52	<110	<110	<110	<56	<56	
Benzo(g,h,i)perylene	<94	<190	<190	<190	<100	<100	
Benzo[a]anthracene/Chrysene	<167	<340	<340	<340	<178	<179	
Benzo[b]/(k)fluoranthene	<157	<320	<320	<320	<167	<167	
Dibenz(a,h)anthracene	<84	<170	<170	<170	<89	<89	
Fluoranthene	<52	<110	<110	<110	<56	<56	
Fluorene	<84	<170	<170	<170	<89	<89	
Indeno(1,2,3-c,d)pyrene	<94	<190	<190	<190	<100	<100	
Naphthalene	<199	<410	<410	<410	<211	<212	
Pyrene	<73	<150	<150	<150	<78	<78	
Cl-1	<10	<21	<21	<21	<11	<11	
Cl-2	<31	<64	<64	<64	<33	<33	
Cl-3	<31	<64	<64	<64	<33	<33	
Cl-4	<21	<43	<43	<43	<22	<22	
Cl-5	<21	<43	<43	<43	<22	<22	
Cl-6	<21	<43	<43	<43	<22	<22	
Cl-7	<31	<64	<64	<64	<33	<33	
Cl-8	<31	<64	<64	<64	<33	<33	
Cl-10	<52	<110	<110	<110	<56	<56	
Total PCB	ND	ND	ND	ND	ND	ND	

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S1 B01-A (09-11)</b>	<b>S1 B01-A (12-14)</b>	<b>S1 B02 (02-04)</b>	<b>S1 B02 (06-08)</b>	<b>S1 B03 (02-04)</b>	<b>S1 B03 (06-08)</b>	<b>S1 B04 (02-04)</b>	<b>S1 B04 (6.2-08)</b>	<b>S1 B04 (9.5-12)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	33	<9.	<8.	<9.	<9.	<9.	540	500	<10.
1,1-Dichloroethane	<7.	<7.	<6.	<6.	<6.	<6.	150	130	<7.
1,1-Dichloroethene	15	<3.	<3.	<3.	<3.	<3.	<4.	<4.	<4.
1,2-Dichloroethane	<15.	<14.	<14.	<14.	<14.	<14.	120	95	<16.
Benzene	<3.	<3.	<3.	7	<3.	4	17	16	<4.
Carbon Tetrachloride	<4.	<4.	<4.	<4.	<4.	<4.	<5.	<6.	<5.
Chlorobenzene	<9.	<9.	<8.	<9.	<9.	<9.	<10.	<11.	<10.
Chloroform	<9.	<9.	<8.	<9.	<9.	<9.	<10.	<11.	<10.
cis-1,2-Dichloroethene	6	<5.	<5.	<5.	<5.	<5.	160000	40000	150
Ethylbenzene	41	<7.	<6.	<6.	<6.	<6.	38	<8.	<7.
m/p-Xylene	160	<17.	<17.	<17.	<17.	<17.	170	<22.	<20.
Methylene Chloride	54	69	64	88	65	71	250	1700	930
o-Xylene	85	<3.	<3.	<3.	<3.	7	73	<4.	4
Styrene	9	<7.	<6.	<6.	<6.	<6.	<7.	<8.	<7.
Tetrachloroethene	<7.	<7.	<6.	<6.	<6.	<6.	110	330	<7.
Toluene	<11.	<11.	<10.	<11.	<11.	<11.	1500	<14.	110
trans-1,2-Dichloroethene	12	<7.	<6.	<6.	<6.	<6.	1500	1400	<7.
Trichloroethene	<20.	<20.	<19.	<19.	<19.	<19.	4600	10000	<22.
Vinyl Chloride	<37.	<36.	<35.	<35.	<35.	<36.	<40.	<46.	<40.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	<87	<84	<87	<86	<43	<96	1300	<98
Acenaphthylene		<130	<130	<130	<130	<65	<140	710	<150
Anthracene/Phenanthrene		<280	<270	<280	<280	<141	<310	5100	<320
Benzo(a)pyrene		<110	<100	<110	<110	<54	<120	<140	<120
Benzo(g,h,i)perylene		<200	<190	<190	<190	<97	<220	<250	<220
Benzo[a]anthracene/Chrysene		<350	<340	<340	<340	<173	<380	2000	<390
Benzo[b]/(k)fluoranthene		<330	<310	<320	<320	<162	<360	<420	<370
Dibenz(a,h)anthracene		<170	<170	<170	<170	<86	<190	<56	<200
Fluoranthene		<110	<100	<110	<110	<54	<120	840	<120
Fluorene		<170	<170	<170	<170	<86	<190	1900	<200
Indeno(1,2,3-c,d)pyrene		<200	<190	<190	<190	<97	<220	<84	<220
Naphthalene	Cl-1 Cl-2 Cl-3 Cl-4 Cl-5 Cl-6 Cl-7 Cl-8 Cl-10 Total PCB	<410	<400	<410	<410	<205	<460	<84	<470
Pyrene		<150	<150	<150	<150	<76	<170	1200	<170
Cl-1		<22	<21	<22	<22	<11	<24	3800	<25
Cl-2		<65	<63	<65	<65	<32	<72	<220	<74
Cl-3		<65	<63	<65	<65	<32	<72	<250	<74
Cl-4		<43	<42	<43	<43	<22	<48	<530	<49
Cl-5		<43	<42	<43	<43	<22	<48	<360	<49
Cl-6		<43	<42	<43	<43	<22	<48	<200	<49
Cl-7		<65	<63	<65	<65	<32	<72	<28	<74
Cl-8		<65	<63	<65	<65	<32	<72	<84	<74
Cl-10		<110	<100	<110	<110	<54	<120	8200	<120
Total PCB		ND	ND	ND	ND	ND	ND	12000	ND

**All measurements in ppb / dry weight**

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S1 B05 (13-15)</b>	<b>S1 B06 (12-13.5)</b>	<b>S1 B07 (13.5-14.5)</b>	<b>S1 B08 (06-08)</b>	<b>S1 B09 (09-11)</b>	<b>S1 B09 (09-11) FD #1</b>	<b>S1 B09 (09-11) FD #2</b>
<b>Volatile Organics</b>							
1,1,1-Trichloroethane	<9.	<9.	<9.	<8.	<8.	<9.	<9.
1,1-Dichloroethane	<7.	<6.	<7.	<6.	<6.	<6.	<6.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	<3.
1,2-Dichloroethane	<14.	<14.	<15.	<13.	<14.	<14.	<14.
Benzene	<3.	<3.	<3.	<3.	<3.	4	8
Carbon Tetrachloride	<4.	<4.	<5.	<4.	<4.	<4.	<4.
Chlorobenzene	<9.	<9.	<9.	<8.	<8.	<9.	<9.
Chloroform	<9.	<9.	<9.	<8.	<8.	<9.	<9.
cis-1,2-Dichloroethene	<5.	<5.	<6.	<5.	<5.	<5.	<5.
Ethylbenzene	<7.	<6.	<7.	<6.	<6.	<6.	<6.
m/p-Xylene	<17.	<17.	<18.	<17.	<17.	<17.	<17.
Methylene Chloride	61	69	74	65	74	74	66
o-Xylene	9	<3.	<3.	<3.	<3.	<3.	<3.
Styrene	<7.	<6.	<7.	<6.	<6.	<6.	<6.
Tetrachloroethene	<7.	<6.	<7.	<6.	<6.	<6.	<6.
Toluene	<11.	<11.	<11.	<10.	<11.	<11.	<11.
trans-1,2-Dichloroethene	<7.	<6.	<7.	<6.	<6.	<6.	<6.
Trichloroethene	<20.	<19.	<20.	<19.	<19.	<19.	<19.
Vinyl Chloride	<36.	<35.	<37.	<34.	<35.	<35.	<35.
<b>Semi-Volatile Organics</b>							
Acenaphthene	<87	<86	<90	<83	<85	<85	N/A
Acenaphthylene	<130	<130	<140	<120	<130	<130	
Anthracene/Phenanthrene	<280	<280	<290	<270	<280	<280	
Benzo(a)pyrene	<110	<110	<110	<100	<110	<110	
Benzo(g,h,i)perylene	<200	<190	<200	<190	<190	<190	
Benzo[a]anthracene/Chrysene	<350	<340	<360	<330	<340	<340	
Benzo[b]/(k)fluoranthene	<330	<320	<340	<310	<320	<320	
Dibenz(a,h)anthracene	<170	<170	<180	<170	<170	<170	
Fluoranthene	<110	<110	<110	<100	<110	<110	
Fluorene	<170	<170	<180	<170	<170	<170	
Indeno(1,2,3-c,d)pyrene	<200	<190	<200	<190	<190	<190	
Naphthalene	<410	<410	<430	<390	<400	<400	
Pyrene	<150	<150	<160	<140	<150	<150	
Cl-1	<22	<21	<23	<21	<21	<21	
Cl-2	<66	<64	<68	<62	<63	<63	
Cl-3	<66	<64	<68	<62	<63	<63	
Cl-4	<44	<43	<45	<41	<42	<42	
Cl-5	<44	<43	<45	<41	<42	<42	
Cl-6	<44	<43	<45	<41	<42	<42	
Cl-7	<66	<64	<68	<62	<63	<63	
Cl-8	<66	<64	<68	<62	<63	<63	
Cl-10	<110	<110	<110	<100	<110	<110	
Total PCB	ND	ND	ND	ND	ND	ND	

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S1 B09 (09-11) FD #3</b>	<b>S1 B10 (06-08)</b>	<b>S1 B10-A (02-04)</b>	<b>S1 B10-A (4.5-06)</b>	<b>S1 B11 (02-04)</b>	<b>S1 B11 (05-06)</b>	<b>S1 B11 (08-9.5)</b>	<b>S1 B12-A (02-04)</b>	<b>S1 B12-A (05-6.5)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<9.	<9.	<8.	<8.	<9.	<9.	<10.	<9.	<9.
1,1-Dichloroethane	<6.	<7.	<6.	<6.	<6.	<6.	<7.	<6.	<6.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	<4.	<3.	<3.
1,2-Dichloroethane	<14.	<14.	<13.	<14.	<14.	<14.	<16.	<14.	<14.
Benzene	7	<3.	<3.	<3.	<3.	<3.	<4.	<3.	<3.
Carbon Tetrachloride	<4.	<4.	<4.	<4.	<4.	<4.	<5.	<4.	<4.
Chlorobenzene	<9.	<9.	<8.	<8.	<9.	<9.	<10.	<9.	<9.
Chloroform	<9.	<9.	<8.	<8.	<9.	<9.	<10.	<9.	<9.
cis-1,2-Dichloroethene	<5.	<6.	<5.	300	<5.	<5.	<6.	<5.	<5.
Ethylbenzene	<6.	<7.	<6.	<6.	<6.	<6.	<7.	<6.	<6.
m/p-Xylene	<17.	<18.	<16.	<17.	<17.	<17.	<20.	<17.	<17.
Methylene Chloride	65	300	74	69	83	360	430	75	63
o-Xylene	<3.	11	<3.	<3.	<3.	8	<4.	<3.	<3.
Styrene	<6.	<7.	<6.	<6.	<6.	<6.	<7.	<6.	<6.
Tetrachloroethene	<6.	<7.	<6.	<6.	<6.	<6.	<7.	<6.	<6.
Toluene	<11.	<11.	<10.	<11.	<11.	<11.	<12.	<11.	<11.
trans-1,2-Dichloroethene	<6.	<7.	<6.	10	<6.	<6.	<7.	<6.	<6.
Trichloroethene	<19.	<20.	<19.	61	<19.	<19.	<22.	<19.	<19.
Vinyl Chloride	<35.	<37.	<34.	<35.	<35.	<35.	<41.	<35.	<35.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	<88	<82	<84	<86	<86	<99	<85	<85
Acenaphthylene		<130	<120	<130	<130	<130	<150	<130	<130
Anthracene/Phenanthrene		<290	<270	<270	<280	<280	<320	<280	<280
Benzo(a)pyrene		<110	<100	<110	<110	<110	<120	<110	<110
Benzo(g,h,i)perylene		<200	<190	<190	<190	<190	<220	<190	<190
Benzo[a]anthracene/Chrysene		<350	<330	<340	<340	<340	<390	<340	<340
Benzo[b]/(k)fluoranthene		<330	<310	<320	<320	<320	<370	<320	<320
Dibenz(a,h)anthracene		<180	<160	<170	<170	<170	<200	<170	<170
Fluoranthene		<110	<100	<110	<110	<110	<120	<110	<110
Fluorene		<180	<160	<170	<170	<170	<200	<170	<170
Indeno(1,2,3-c,d)pyrene		<200	<190	<190	<190	<190	<220	<190	<190
Naphthalene	Cl-1 Cl-2 Cl-3 Cl-4 Cl-5 Cl-6 Cl-7 Cl-8 Cl-10 Total PCB	<420	<390	<400	<410	<410	<470	<410	<410
Pyrene		<160	<140	<150	<150	<150	<170	<150	<150
Cl-1		<22	<21	<21	<21	<21	<25	<21	<21
Cl-2		<66	<62	<63	<64	<64	<74	<64	<64
Cl-3		<66	<62	<63	<64	<64	<74	<64	<64
Cl-4		<44	<41	<42	<43	<43	<49	<43	<43
Cl-5		<44	<41	<42	<43	<43	<49	<43	<43
Cl-6		<44	<41	<42	<43	<43	<49	<43	<43
Cl-7		<66	<62	<63	<64	<64	<74	<64	<64
Cl-8		<66	<62	<63	<64	<64	<74	<64	<64
Cl-10		<110	<100	<110	<110	<110	<120	<110	<110
Total PCB		ND	ND	ND	ND	ND	ND	ND	ND

**All measurements in ppb / dry weight**

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S1 B12-D (06-08)</b>	<b>S1 B12-E (5-7)</b>	<b>S1 B13 (02-04)</b>	<b>S1 B13 (06-08)</b>	<b>S1 B13-A (06-08)</b>	<b>S1 B14 (02-04)</b>	<b>S1 B14 (04-06)</b>	<b>S1 B15 (02-04)</b>	<b>S1 B15 (06-08)</b>	<b>S1 B16-A (06-08)</b>
<b>Volatile Organics</b>										
1,1,1-Trichloroethane	<9.	<8.	<9.	<44.	<8.	<9.	<9.	<9.	<9.	<11.
1,1-Dichloroethane	<6.	<6.	<7.	<33.	<6.	<7.	<6.	<7.	<7.	<8.
1,1-Dichloroethene	<3.	<3.	<3.	<16.	<3.	<3.	<3.	<3.	<3.	<4.
1,2-Dichloroethane	<14.	<14.	<14.	<71.	<14.	<14.	<14.	<14.	<15.	<18.
Benzene	<3.	7	4	<16.	<3.	<3.	<3.	<3.	4	<4.
Carbon Tetrachloride	<4.	<4.	<4.	<22.	<4.	<4.	<4.	<4.	<5.	<6.
Chlorobenzene	<9.	<8.	<9.	<44.	<8.	<9.	<9.	<9.	<9.	<11.
Chloroform	<9.	<8.	<9.	<44.	<8.	<9.	<9.	<9.	<9.	<11.
cis-1,2-Dichloroethene	<5.	<5.	<5.	<27.	<5.	<5.	<5.	<5.	<6.	42
Ethylbenzene	<6.	<6.	<7.	1700	<6.	<7.	<6.	<7.	<7.	40
m/p-Xylene	<17.	<17.	<18.	1600	<17.	<17.	<17.	<17.	<18.	44
Methylene Chloride	67	79	57	<120	68	67	70	66	72	130
o-Xylene	<3.	<3.	13	370	<3.	<3.	<3.	<3.	<3.	16
Styrene	<6.	<6.	<7.	<33.	<6.	<7.	<6.	<7.	<7.	<8.
Tetrachloroethene	<6.	<6.	<7.	<33.	<6.	<7.	<6.	<7.	<7.	<8.
Toluene	<11.	<11.	<11.	<54.	<11.	<11.	<11.	<11.	<11.	140
trans-1,2-Dichloroethene	<6.	<6.	<7.	<33.	<6.	<7.	<6.	<7.	<7.	<8.
Trichloroethene	<19.	<19.	<20.	<98.	<19.	<20.	<19.	<20.	<21.	<25.
Vinyl Chloride	<35.	<35.	<36.	<180	<35.	<36.	<35.	<36.	<38.	<46.
<b>Semi-Volatile Organics</b>										
Acenaphthene	<86	<85	<88	<87	N/A		<87	<86	<87	<91
Acenaphthylene	<130	<130	<130	<130	<130		<130	<130	<130	<140
Anthracene/Phenanthrene	<280	<270	<290	<280	<280		<280	<280	<300	<360
Benzo(a)pyrene	<110	<110	<110	<110	<100		<110	<110	<110	<140
Benzo(g,h,i)perylene	<190	<190	<200	<200	<200		<190	<200	<210	<250
Benzo[a]anthracene/Chrysene	<340	<340	<350	<350	<350		<350	<350	<370	<440
Benzo[b]/(k)fluoranthene	<320	<320	<330	<330	<330		<320	<330	<340	<420
Dibenz(a,h)anthracene	<170	<170	<180	<170	<170		<170	<170	<180	<220
Fluoranthene	<110	<110	<110	<110	<110		<110	<110	<110	<140
Fluorene	<170	<170	<180	<170	<170		<170	<170	<180	<220
Indeno(1,2,3-c,d)pyrene	<190	<190	<200	<200	<200		<190	<200	<210	<250
Naphthalene	<410	<400	<420	<410	<410		<410	<410	<430	<530
Pyrene	<150	<150	<150	<150	<150		<150	<150	<160	<190
Cl-1	<21	<21	<22	<22	<22		<22	<22	<23	<28
Cl-2	<64	<63	<66	<65	<65		<65	<65	<68	<83
Cl-3	<64	<63	<66	<65	<65		<65	<65	<68	<83
Cl-4	<43	<42	<44	<44	<43		<43	<44	<46	<55
Cl-5	<43	<42	<44	<44	<43		<43	<44	<46	<55
Cl-6	<43	<42	<44	<44	<43		<43	<44	<46	<55
Cl-7	<64	<63	<66	<65	<65		<65	<65	<68	<83
Cl-8	<64	<63	<66	<65	<65		<65	<65	<68	<83
Cl-10	<110	<110	<110	<110	<110		<110	<110	<110	<140
Total PCB	ND	ND	ND	ND	ND		ND	ND	ND	ND

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S1 B16-A (09-11)</b>	<b>S1 B17-1 (02-04)</b>	<b>S1 B17-1 (02-04) FD #1</b>	<b>S1 B17-1 (02-04) FD #2</b>	<b>S1 B17-2 (10-12)</b>	<b>S1 B17-A (02-04)</b>	<b>S1 B17-A (10-12)</b>	<b>S1 B17-A (5.75-08)</b>
<b>Volatile Organics</b>								
1,1,1-Trichloroethane	<13.	<9.	<8.	<8.	<9.	210	<9.	18
1,1-Dichloroethane	<10.	<6.	<6.	<6.	<7.	<7.	<6.	<7.
1,1-Dichloroethene	<5.	<3.	<3.	<3.	<3.	<4.	<3.	<3.
1,2-Dichloroethane	<21.	<14.	<14.	<14.	<14.	<15.	<14.	<14.
Benzene	10	10	8	<3.	6	12	7	<3.
Carbon Tetrachloride	9	<4.	<4.	<4.	<4.	<5.	<4.	<4.
Chlorobenzene	<13.	<9.	<8.	<8.	<9.	<10.	<9.	<9.
Chloroform	<13.	<9.	<8.	<8.	<9.	<10.	<9.	<9.
cis-1,2-Dichloroethene	120	<5.	<5.	<5.	<5.	4800	9	810
Ethylbenzene	230	<6.	<6.	<6.	<7.	<7.	<6.	<7.
m/p-Xylene	330	<17.	<17.	<17.	<17.	<19.	<17.	<17.
Methylene Chloride	190	78	76	78	75	130	69	71
o-Xylene	110	<3.	<3.	<3.	<3.	6	<3.	<3.
Styrene	<10.	<6.	<6.	<6.	<7.	<7.	<6.	<7.
Tetrachloroethene	<10.	<6.	<6.	<6.	<7.	66	<6.	<7.
Toluene	230	<11.	<11.	<11.	<11.	<12.	<11.	<11.
trans-1,2-Dichloroethene	<10.	<6.	<6.	<6.	<7.	180	<6.	11
Trichloroethene	<30.	<19.	<19.	<19.	<20.	82	<19.	29
Vinyl Chloride	<54.	<35.	<35.	<35.	<36.	<39.	<36.	<36.
<b>Semi-Volatile Organics</b>								
Acenaphthene	<130	N/A	<85		<87	<200	<43	<220
Acenaphthylene	<200		<130		<130	<290	<65	<330
Anthracene/Phenanthrene	<430		<270		<280	<630	<140	<700
Benzo(a)pyrene	<160		<110		<110	<240	<54	290
Benzo(g,h,i)perylene	<300		<190		<200	<440	<97	<490
Benzo[a]anthracene/Chrysene	<530		<340		<350	900	<172	<870
Benzo[b]/(k)fluoranthene	<490		<320		<330	<730	<161	<810
Dibenz(a,h)anthracene	<260		<170		<170	<390	<86	<430
Fluoranthene	<170		<110		<110	<240	<54	<270
Fluorene	<260		<170		<170	<390	<86	<430
Indeno(1,2,3-c,d)pyrene	<300		<190		<200	<440	<97	<490
Naphthalene	<630		<400		<410	<930	<204	<1000
Pyrene	<230		<150		<150	<340	<75	<380
Cl-1	<33		<21		<22	<50	<11	<54
Cl-2	<99		<63		<65	<150	<32	<160
Cl-3	<99		<63		<65	<150	<32	<160
Cl-4	<66		<42		<44	<100	<22	<110
Cl-5	<66		<42		<44	<100	<22	<110
Cl-6	<66		<42		<44	<100	<22	<110
Cl-7	<99		<63		<65	<150	<32	<160
Cl-8	<99		<63		<65	<150	<32	<160
Cl-10	<170		<110		<110	<240	<54	<270
Total PCB	ND		ND		ND	ND	ND	ND

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S1 B18 (05-07)</b>	<b>S1 B18 (05-07)</b>	<b>S1 B18 (10-12)</b>	<b>S2 B01 (12-14)</b>	<b>S2 B01 (20-22)</b>	<b>S2 B02 (13-15)</b>	<b>S2 B02 (13-15)-R</b>	<b>S2 B02 (16-18)</b>	<b>S2 B02 (20-22)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<9.		<9.	36	<46.	20	<9.	15000	300
1,1-Dichloroethane	<7.		<6.	<6.	<34.	<7.	<7.	3200	41
1,1-Dichloroethene	<3.		<3.	<3.	<17.	<3.	<3.	870	30
1,2-Dichloroethane	<15.		<14.	<14.	<75.	<14.	<15.	290	<15.
Benzene	<3.		<3.	<3.	<17.	<3.	<3.	24	<3.
Carbon Tetrachloride	<4.		<4.	<4.	<23.	<4.	<4.	<9	<5.
Chlorobenzene	<9.		<9.	<9.	<46.	<9.	<9.	32	<9.
Chloroform	<9.		<9.	<9.	<46.	<9.	<9.	<18	<9.
cis-1,2-Dichloroethene	<6.		<5.	10	120	13	<6.	1600	560
Ethylbenzene	<7.		<6.	53	830	550	58	1900	990
m/p-Xylene	<18.		<17.	140	3400	2100	<18.	12000	7400
Methylene Chloride	120		68	700	3700	810	280	370	520
o-Xylene	4		<3.	54	750	980	290	3500	2300
Styrene	<7.		<6.	<6.	<34.	<7.	<7.	<13	<7.
Tetrachloroethene	<7.		<6.	170	110	540	42	920	120
Toluene	<11.		<11.	390	22000	9100	<11.	36000	37000
trans-1,2-Dichloroethene	<7.		<6.	<6.	<34.	<7.	<7.	19	<7.
Trichloroethene	<20.		<19.	<19.	<100	<20.	<20.	67	<21.
Vinyl Chloride	<37.		<35.	<35.	<190	<36.	<37.	<73	<38.
<b>Semi-Volatile Organics</b>									
Acenaphthene	<450	<90	<85		N/A		N/A		N/A
Acenaphthylene	<670	<130	<130			190			
Anthracene/Phenanthrene	<1500	<290	<280			<300			
Benzo(a)pyrene	<560	<110	<110			<120			
Benzo(g,h,i)perylene	<1000	<200	<190			<210			
Benzo[a]anthracene/Chrysene	<1800	<360	<340			<370			
Benzo[b]/(k)fluoranthene	<1700	<340	<320			<350			
Dibenz(a,h)anthracene	<900	<180	<170			<190			
Fluoranthene	<560	<110	<110			<120			
Fluorene	<900	<180	<170			<190			
Indeno(1,2,3-c,d)pyrene	<1000	<200	<190			<210			
Naphthalene	<2100	<430	<400			<440			
Pyrene	<800	<160	<150			<160			
Cl-1	<110	<22	<21			<23			
Cl-2	<340	<67	<64			<70			
Cl-3	<340	<67	<64			<70			
Cl-4	<230	<45	<43			<47			
Cl-5	<230	<45	<43			<47			
Cl-6	<230	<45	<43			<47			
Cl-7	<340	<67	<64			<70			
Cl-8	<340	<67	<64			<70			
Cl-10	<560	<110	<110			<120			
Total PCB	ND	ND	ND			ND			

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S2 B02 (20-22) FD1</b>	<b>S2 B02 (20-22) FD2</b>	<b>S2 B02-1A (9.5-11)</b>	<b>S2 B03 (10-12)</b>	<b>S2 B03 (13-15)</b>	<b>S2 B03 (16-18)</b>	<b>S2 B03 (18-20)</b>	<b>S2 B04 (10-12)</b>	<b>S2 B04 (13-15)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<10.	<10.	<9.	<9.	<9.	<9.	<9.	<9.	<9.
1,1-Dichloroethane	<7.	<7.	<7.	<6.	<6.	<7.	<7.	<7.	<6.
1,1-Dichloroethene	<4.	<4.	<3.	<3.	<3.	<3.	<4.	<3.	<3.
1,2-Dichloroethane	<15.	<15.	<15.	<14.	<14.	<14.	<15.	<14.	<14.
Benzene	<4.	<4.	4	<3.	<3.	4	<4.	<3.	<3.
Carbon Tetrachloride	<5.	<5.	<5.	<4.	<4.	<4.	<5.	<4.	<4.
Chlorobenzene	<10.	<10.	<9.	<9.	<9.	<9.	<9.	<9.	<9.
Chloroform	<10.	<10.	<9.	<9.	<9.	<9.	<9.	<9.	<9.
cis-1,2-Dichloroethene	7	<6.	<6.	<5.	<5.	<6.	<6.	<5.	<5.
Ethylbenzene	26	<7.	<7.	98	1700	640	340	<7.	390
m/p-Xylene	92	<19.	<18.	<17.	17000	15000	2100	<18.	870
Methylene Chloride	740	480	91	640	630	470	430	630	400
o-Xylene	81	6	<3.	170	4300	2500	530	8	970
Styrene	<7.	<7.	<7.	<6.	<6.	<7.	<7.	<7.	<6.
Tetrachloroethene	<7.	<7.	<7.	<6.	<6.	16	<7.	<7.	41
Toluene	120	58	<11.	<11.	24000	9600	930	<11.	1100
trans-1,2-Dichloroethene	<7.	<7.	<7.	<6.	<6.	<7.	<7.	<7.	<6.
Trichloroethene	<21.	<21.	<21.	<19.	<19.	<20.	<21.	<20.	<19.
Vinyl Chloride	<39.	<39.	<38.	<35.	<35.	<36.	<39.	<36.	<35.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	370
Acenaphthylene									1200
Anthracene/Phenanthrene									<280
Benzo(a)pyrene									970
Benzo(g,h,i)perylene									<190
Benzo[a]anthracene/Chrysene									<340
Benzo[b]/(k)fluoranthene									770
Dibenz(a,h)anthracene									<170
Fluoranthene									1100
Fluorene									<170
Indeno(1,2,3-c,d)pyrene									<190
Naphthalene									5400
Pyrene									690
Cl-1									<21
Cl-2									<64
Cl-3									<64
Cl-4									<43
Cl-5									<43
Cl-6									1300
Cl-7									<64
Cl-8									7500
Cl-10									<110
Total PCB									8800

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S2 B04 (16-18)</b>	<b>S2 B04 (19-21)</b>	<b>S2 B05 (02-04)</b>	<b>S2 B05 (06-08)</b>	<b>S2 B05 (08-10)</b>	<b>S2 B05 (10-12)</b>	<b>S2 B06 (02-04)</b>	<b>S2 B06 (06-08)</b>	<b>S2 B06 (10-12)</b>	<b>S2 B07 (02-04)</b>
<b>Volatile Organics</b>										
1,1,1-Trichloroethane	<9.	<9.	<8.	<9.	<9.	<9.	<9.	<9.	<9.	<9.
1,1-Dichloroethane	<7.	<7.	<6.	<7.	<7.	<7.	<6.	<6.	<7.	<6.
1,1-Dichloroethene	<3.	<4.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.
1,2-Dichloroethane	<15.	<15.	<13.	<15.	<14.	<15.	<14.	<14.	<15.	<14.
Benzene	<3.	<4.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	4
Carbon Tetrachloride	<4.	<5.	<4.	<4.	<4.	<5.	<4.	<4.	<5.	<4.
Chlorobenzene	<9.	<9.	<8.	<9.	<9.	<9.	<9.	<9.	<9.	<9.
Chloroform	<9.	<9.	<8.	<9.	16	<9.	<9.	<9.	<9.	<9.
cis-1,2-Dichloroethene	<6.	<6.	<5.	<6.	<6.	10	<5.	<5.	<6.	<5.
Ethylbenzene	190	410	<6.	<7.	<7.	<7.	<6.	<6.	<7.	<6.
m/p-Xylene	340	640	<17.	<18.	<18.	<19.	<17.	<17.	<18.	<17.
Methylene Chloride	37	42	86	540	410	650	440	400	380	72
o-Xylene	490	530	<3.	<3.	5	<3.	<3.	<3.	<3.	<3.
Styrene	<7.	<7.	<6.	<7.	<7.	<7.	<6.	<6.	<7.	<6.
Tetrachloroethene	<7.	<7.	<6.	<7.	<7.	<7.	<6.	<6.	<7.	<6.
Toluene	250	20	<10.	<11.	<11.	<12.	<11.	<11.	<11.	<11.
trans-1,2-Dichloroethene	<7.	<7.	<6.	<7.	<7.	<7.	<6.	<6.	<7.	<6.
Trichloroethene	<20.	<21.	<19.	<20.	<20.	<21.	<19.	<19.	<20.	<19.
Vinyl Chloride	<37.	<39.	<34.	<37.	<37.	<38.	<35.	<35.	<38.	<35.
<b>Semi-Volatile Organics</b>										
Acenaphthene	N/A		N/A	N/A	<89	N/A	N/A	N/A	N/A	<85
Acenaphthylene		250			<130					<130
Anthracene/Phenanthrene		1300			<290					<280
Benzo(a)pyrene		<310			<110					<110
Benzo(g,h,i)perylene		<120			<200					<190
Benzo[a]anthracene/Chrysene		<210			<350					<340
Benzo[b]/(k)fluoranthene		<380			<330					<320
Dibenz(a,h)anthracene		<350			<180					<170
Fluoranthene		<190			<110					<110
Fluorene		<190			<180					<170
Indeno(1,2,3-c,d)pyrene		<210			<200					<190
Naphthalene		17000			<420					<400
Pyrene		360			<160					<150
Cl-1					<24					<21
Cl-2					<71					<64
Cl-3					<71					<64
Cl-4					<47					<43
Cl-5					<47					<43
Cl-6					<47					<43
Cl-7					<71					<64
Cl-8					<71					<64
Cl-10					<120					<110
Total PCB			ND		ND					ND

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S2 B07 (05-07)</b>	<b>S2 B07 (08-10)</b>	<b>S2 B08 (08-10)</b>	<b>S2 B08 (12-14)</b>	<b>S2 B08 (15-17)</b>	<b>S2 B08 (18-20)</b>	<b>S2 B09 (06-08)</b>	<b>S2 B09 (10-12)</b>	<b>S2 B10 (06-08)</b>	<b>S2 B10 (10-12)</b>
<b>Volatile Organics</b>										
1,1,1-Trichloroethane	<9.	<9.	<9.	<8.	<9.	20	<9.	<9.	<9.	<9.
1,1-Dichloroethane	<6.	<6.	<6.	<6.	<7.	<7.	<6.	<6.	<6.	<7.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.
1,2-Dichloroethane	<14.	<14.	<14.	<14.	<15.	<15.	<14.	<14.	<14.	<14.
Benzene	<3.	4	8	<3.	<3.	<3.	<3.	<3.	4	4
Carbon Tetrachloride	<4.	<4.	<4.	<4.	<4.	<5.	<4.	<4.	<4.	<4.
Chlorobenzene	<9.	<9.	<9.	<8.	<9.	<9.	<9.	<9.	<9.	<9.
Chloroform	<9.	<9.	<9.	<8.	<9.	26	<9.	<9.	<9.	<9.
cis-1,2-Dichloroethene	<5.	<5.	<5.	<5.	<6.	<6.	<5.	<5.	<5.	<5.
Ethylbenzene	<6.	<6.	<6.	<6.	<7.	15	<6.	<6.	<6.	<7.
m/p-Xylene	<17.	<17.	<17.	<17.	<18.	34	<17.	<17.	<17.	<17.
Methylene Chloride	60	790	72	350	380	400	820	760	820	340
o-Xylene	<3.	<3.	<3.	<3.	<3.	44	<3.	<3.	<3.	<3.
Styrene	<6.	<6.	<6.	<6.	<7.	18	<6.	<6.	<6.	<7.
Tetrachloroethene	<6.	<6.	<6.	<6.	<7.	<7.	<6.	<6.	<6.	<7.
Toluene	<11.	<11.	<11.	<10.	<11.	48	<11.	<11.	<11.	<11.
trans-1,2-Dichloroethene	<6.	<6.	<6.	<6.	<7.	22	<6.	<6.	<6.	<7.
Trichloroethene	<19.	<19.	<19.	<19.	<20.	<21.	<19.	<19.	<19.	<20.
Vinyl Chloride	<35.	<35.	<36.	<34.	<37.	<38.	<35.	<35.	<35.	<36.
<b>Semi-Volatile Organics</b>										
Acenaphthene	<85	N/A	N/A		<84					
Acenaphthylene	<130				<130					
Anthracene/Phenanthrene	<280				<270					
Benzo(a)pyrene	<110				<100					
Benzo(g,h,i)perylene	<190				<190					
Benzo[a]anthracene/Chrysene	<340				<340					
Benzo[b]/(k)fluoranthene	<320				<310					
Dibenz(a,h)anthracene	<170				<170					
Fluoranthene	<110				<100					
Fluorene	<170				<170					
Indeno(1,2,3-c,d)pyrene	<190				<190					
Naphthalene	<400				<400					
Pyrene	<150				<150					
Cl-1	<21				<21					
Cl-2	<64				<63					
Cl-3	<64				<63					
Cl-4	<43				<42					
Cl-5	<43				<42					
Cl-6	<43				<42					
Cl-7	<64				<63					
Cl-8	<64				<63					
Cl-10	<110				<100					
Total PCB	ND				ND					

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S2 B11 (08-10)</b>	<b>S2 B11 (12-14)</b>	<b>S2 B11 (14-16)</b>	<b>S2 B11 (16-18)</b>	<b>S2 B12 (09-11)</b>	<b>S2 B12 (12-14)</b>	<b>S2 B12 (18-20)</b>	<b>S2 B12 (18-20) FD #1</b>
<b>Volatile Organics</b>								
1,1,1-Trichloroethane	<9.	<9.	<9.	<10.	<9.	<9.	<9.	<10.
1,1-Dichloroethane	<6.	<6.	<6.	<7.	<6.	<7.	<7.	<7.
1,1-Dichloroethene	<3.	<3.	<3.	<4.	<3.	<3.	<3.	<4.
1,2-Dichloroethane	<14.	<14.	<14.	<16.	<14.	<14.	<15.	<15.
Benzene	<3.	<3.	<3.	<4.	9	<3.	<3.	9
Carbon Tetrachloride	<4.	<4.	<4.	<5.	<4.	<4.	<5.	<5.
Chlorobenzene	<9.	<9.	<9.	<10.	<9.	<9.	<9.	<10.
Chloroform	<9.	<9.	<9.	<10.	14	<9.	<9.	<10.
cis-1,2-Dichloroethene	<5.	<5.	<5.	<6.	<5.	<5.	<6.	<6.
Ethylbenzene	<6.	<6.	<6.	<7.	19	<7.	<7.	<7.
m/p-Xylene	<17.	<17.	<17.	<19.	51	<17.	<18.	<19.
Methylene Chloride	730	300	270	630	500	340	630	76
o-Xylene	<3.	<3.	<3.	12	30	<3.	<3.	<4.
Styrene	<6.	<6.	<6.	<7.	<6.	<7.	<7.	<7.
Tetrachloroethene	<6.	<6.	<6.	<7.	<6.	<7.	<7.	<7.
Toluene	<11.	<11.	<11.	<12.	73	<11.	<11.	<12.
trans-1,2-Dichloroethene	<6.	<6.	<6.	<7.	<6.	<7.	<7.	<7.
Trichloroethene	<19.	<19.	<19.	<22.	<19.	<20.	<20.	<21.
Vinyl Chloride	<35.	<35.	<35.	<40.	<35.	<36.	<38.	<39.
<b>Semi-Volatile Organics</b>								
Acenaphthene	N/A	N/A	N/A	N/A	N/A	<87	<91	N/A
Acenaphthylene						<130	<140	
Anthracene/Phenanthrene						<280	<300	
Benzo(a)pyrene						<110	<110	
Benzo(g,h,i)perylene						<200	<200	
Benzo[a]anthracene/Chrysene						<350	<360	
Benzo[b]/(k)fluoranthene						<330	<340	
Dibenz(a,h)anthracene						<170	<180	
Fluoranthene						<110	<110	
Fluorene						<170	<180	
Indeno(1,2,3-c,d)pyrene						<200	<200	
Naphthalene						<410	<430	
Pyrene						<150	<160	
Cl-1						<22	<23	
Cl-2						<66	<68	
Cl-3						<66	<68	
Cl-4						<44	<45	
Cl-5						<44	<45	
Cl-6						<44	<45	
Cl-7						<66	<68	
Cl-8						<66	<68	
Cl-10						<110	<110	
Total PCB						ND	ND	

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S2 B12 (18-20) FD #2</b>	<b>S2 B13 (08-10)</b>	<b>S2 B13 (14-16)</b>	<b>S2 B13 (14-16)-R</b>	<b>S2 B13 (18-20)</b>	<b>S2 B14 (08-10)</b>	<b>S2 B14 (12-14)</b>	<b>S2 B14 (18-20)</b>	<b>S2 B15 (10-12)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<10.	<9.	31	<94	210	<9.	<9.	24	<9.
1,1-Dichloroethane	<7.	<6.	<6.	<70	15	<7.	<6.	<7.	<7.
1,1-Dichloroethene	<4.	<3.	<3.	<35	51	<3.	<3.	<4.	<3.
1,2-Dichloroethane	<15.	<14.	<14.	<150	<15.	<14.	<14.	<15.	<14.
Benzene	5	<3.	<3.	<35	9	<3.	<3.	<4.	<3.
Carbon Tetrachloride	<5.	<4.	<4.	<47	<4.	<4.	<4.	<5.	<4.
Chlorobenzene	<10.	<9.	<9.	<94	<9.	<9.	<9.	<9.	<9.
Chloroform	<10.	<9.	<9.	<94	<9.	<9.	<9.	<9.	<9.
cis-1,2-Dichloroethene	<6.	30	380	<59	15000	<5.	<5.	110	<5.
Ethylbenzene	<7.	<6.	160	<59	230	14	<6.	28	<7.
m/p-Xylene	<19.	<17.	210	2200	640	54	<17.	86	<17.
Methylene Chloride	74	490	640	990	160	410	390	200	400
o-Xylene	<4.	<3.	95	2700	190	27	10	67	<3.
Styrene	<7.	<6.	<6.	<70	<7.	<7.	<6.	<7.	<7.
Tetrachloroethene	<7.	<6.	42	<70	25	<7.	<6.	<7.	<7.
Toluene	<12.	<11.	1600	<120	5500	43	<11.	390	<11.
trans-1,2-Dichloroethene	<7.	<6.	<6.	<70	45	<7.	<6.	<7.	<7.
Trichloroethene	<21.	<19.	<19.	<210	<20.	<20.	<19.	<21.	<20.
Vinyl Chloride	<39.	<35.	<35.	<390	<37.	<36.	<35.	<39.	<36.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	N/A		<85	N/A	N/A	N/A	N/A	N/A
Acenaphthylene				1200					<140
Anthracene/Phenanthrene				<280					<310
Benzo(a)pyrene				830					<120
Benzo(g,h,i)perylene				<190					<210
Benzo[a]anthracene/Chrysene				290					<380
Benzo[b]/(k)fluoranthene				620					<350
Dibenz(a,h)anthracene				260					<190
Fluoranthene				<110					<120
Fluorene				<170					<190
Indeno(1,2,3-c,d)pyrene				240					<210
Naphthalene				650					<450
Pyrene				410					<170
Cl-1				<21					<24
Cl-2				<64					<71
Cl-3				56					<71
Cl-4				<43					<47
Cl-5				<43					<47
Cl-6				1200					<47
Cl-7				<64					<71
Cl-8				5600					<71
Cl-10				<110					<120
Total PCB				6856					ND

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S2 B15 (14-16)</b>	<b>S2 B15 (14-16)</b>	<b>S2 B15-A (10-12)</b>	<b>S2 B15-A (14-16)-R</b>	<b>S2 B15-A (18-20)-R</b>	<b>S2 B27-A (09-11)</b>	<b>S2 B01 (10-12)</b>	<b>S3 B01 (13-15)</b>	<b>S3 B01 (17-19)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	99	140	<9.	<9.	<9.	<9.	<9.	<86.	<9.
1,1-Dichloroethane	68	<33.	<6.	<6.	<7.	<7.	<7.	<64.	<7.
1,1-Dichloroethene	100	<17.	<3.	<3.	<4.	<4.	<3.	<32.	<3.
1,2-Dichloroethane	30	<72.	<14.	<14.	<15.	<15.	<15.	<140	<14.
Benzene	330	140	<3.	<3.	<4.	5	<3.	<32.	4
Carbon Tetrachloride	<9.	<22.	<4.	<4.	<5.	<5.	<4.	<43.	<4.
Chlorobenzene	36	<44.	<9.	<9.	<9.	<9.	<9.	<86.	<9.
Chloroform	<18.	53	<9.	<9.	<9.	<9.	<9.	<86.	<9.
cis-1,2-Dichloroethene	2200	430	<5.	<5.	<6.	<6.	<6.	<54.	11
Ethylbenzene	500	1800	<6.	54	63	<7.	730	13000	<7.
m/p-Xylene	1300	1400	<17.	150	300	<19.	9100	320000	<18.
Methylene Chloride	450000	34000	410	240	120	84	180	880	430
o-Xylene	1000	1400	4	410	430	<4.	1300	83000	8
Styrene	<13.	<33.	<6.	<6.	<7.	<7.	<7.	<64.	<7.
Tetrachloroethene	250	260	<6.	<6.	<7.	<7.	<7.	<64.	<7.
Toluene	8300	4300	<11.	120	60	<12.	390	280000	<11.
trans-1,2-Dichloroethene	1500	460	<6.	<6.	<7.	<7.	<7.	<64.	23
Trichloroethene	2100000	810000	<19.	<19.	<21.	<21.	<20.	<190	<20.
Vinyl Chloride	<73.	<180	<35.	<35.	<39.	<39.	<37.	<350	<37.
<b>Semi-Volatile Organics</b>									
Acenaphthene	380	N/A	N/A	N/A	N/A	N/A	N/A	<86	
Acenaphthylene	1100							<130	
Anthracene/Phenanthrene	<580							<280	
Benzo(a)pyrene	850							<110	
Benzo(g,h,i)perylene	780							<190	
Benzo[a]anthracene/Chrysene	<710							<340	
Benzo[b]/(k)fluoranthene	870							<320	
Dibenz(a,h)anthracene	590							<170	
Fluoranthene	960							<110	
Fluorene	<350							<170	
Indeno(1,2,3-c,d)pyrene	550							<190	
Naphthalene	2600							<410	
Pyrene	800							<150	
Cl-1	<44							<21	
Cl-2	<133							<64	
Cl-3	<133							<64	
Cl-4	<88							820	
Cl-5	<88							1200	
Cl-6	<88							57	
Cl-7	<133							<64	
Cl-8	<133							690	
Cl-10	<221							<110	
Total PCB	ND							2767	

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S3 B02 (10-12)</b>	<b>S3 B02 (12-14)</b>	<b>S3 B02 (12-14) FD1</b>	<b>S3 B02 (12-14) FD2</b>	<b>S3 B02 (17-19)</b>	<b>S3 B03 (02-04)</b>	<b>S3 B03 (06-08)</b>	<b>S3 B03 (10-12)</b>	<b>S3 B03 (14-16)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<9.	<9.	<8.	<8.	<9.	<9.	<8.	<9.	<9.
1,1-Dichloroethane	<6.	<6.	<6.	<6.	<7.	<7.	<6.	<7.	<6.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.
1,2-Dichloroethane	<14.	<14.	<14.	<14.	<15.	<14.	<14.	<14.	<14.
Benzene	4	5	4	<3.	<3.	<3.	<3.	<3.	<3.
Carbon Tetrachloride	<4.	<4.	7	7	<5.	<4.	<4.	<4.	<4.
Chlorobenzene	<9.	<9.	<8.	<8.	<9.	<9.	<8.	<9.	<9.
Chloroform	<9.	<9.	<8.	<8.	<9.	<9.	<8.	<9.	<9.
cis-1,2-Dichloroethene	10	<5.	5	<5.	<6.	<5.	<5.	26	<5.
Ethylbenzene	<6.	22	<6.	<6.	67	<7.	<6.	38	14
m/p-Xylene	<17.	130	<17.	<17.	720	<18.	<17.	<17.	99
Methylene Chloride	820	91	78	79	100	830	670	860	160
o-Xylene	<3.	40	17	4	310	<3.	<3.	<3.	5600
Styrene	<6.	<6.	<6.	<6.	<7.	<7.	<6.	<7.	<6.
Tetrachloroethene	<6.	<6.	<6.	<6.	<7.	<7.	<6.	<7.	<6.
Toluene	<11.	<11.	<11.	<11.	150	<11.	<11.	<11.	160
trans-1,2-Dichloroethene	<6.	<6.	<6.	<6.	<7.	<7.	<6.	<7.	<6.
Trichloroethene	<19.	<19.	<19.	<19.	<20.	<20.	<19.	<20.	<19.
Vinyl Chloride	<35.	<35.	<35.	<35.	<37.	<36.	<35.	<36.	<35.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	N/A	N/A	N/A	N/A	<88		<87	
Acenaphthylene						<130		<130	
Anthracene/Phenanthrene						<290		<280	
Benzo(a)pyrene						<110		<110	
Benzo(g,h,i)perylene						<200		<200	
Benzo[a]anthracene/Chrysene						<350		<350	
Benzo[b]/(k)fluoranthene						<330		<330	
Dibenz(a,h)anthracene						<180		<170	
Fluoranthene						<110		<110	
Fluorene						<180		<170	
Indeno(1,2,3-c,d)pyrene						<200		<200	
Naphthalene						<420		<410	
Pyrene						<150		<150	
Cl-1						<22		<22	
Cl-2						<66		<65	
Cl-3						<66		<65	
Cl-4						<44		<44	
Cl-5						<44		160	
Cl-6						<44		200	
Cl-7						<66		<65	
Cl-8						<66		<65	
Cl-10						<110		<110	
Total PCB						ND		360	

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S3 B04 (10-12)</b>	<b>S3 B04 (12.5-14)</b>	<b>S3 B05 (10-12)</b>	<b>S3 B05 (14-16)</b>	<b>S3 B05 (17-19)</b>	<b>S3 B06 (10-12)</b>	<b>S3 B06 (13-15)</b>	<b>S3 B06 (16-18)</b>	<b>S3 B07 (10-12)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<9.	<9.	<9.	<9.	<9.	<9.	80	<10.	<9.
1,1-Dichloroethane	<7.	<7.	<7.	<6.	<7.	<7.	<7.	<7.	<7.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	24	<4.	<3.
1,2-Dichloroethane	<14.	<15.	<14.	<14.	<14.	<14.	<14.	<16.	<14.
Benzene	6	<3.	4	<3.	<3.	5	6	<4.	5
Carbon Tetrachloride	<4.	<4.	<4.	<4.	<4.	<4.	9	<5.	<4.
Chlorobenzene	<9.	<9.	<9.	<9.	<9.	<9.	<9.	<10.	<9.
Chloroform	<9.	<9.	<9.	<9.	<9.	<9.	19	<10.	<9.
cis-1,2-Dichloroethene	<5.	<6.	110	<5.	6	16	9	<6.	24
Ethylbenzene	280	670	35	4300	<7.	22	50	<7.	8
m/p-Xylene	110	3600	86	31000	<17.	28	150	<19.	<18.
Methylene Chloride	130	410	860	33	390	73	100	65	87
o-Xylene	1000	1800	39	12000	<3.	18	94	<4.	17
Styrene	<7.	<7.	<7.	<6.	<7.	<7.	48	<7.	<7.
Tetrachloroethene	<7.	<7.	<7.	<6.	<7.	<7.	61	<7.	<7.
Toluene	60	200	140	15000	<11.	33	22	<12.	<11.
trans-1,2-Dichloroethene	<7.	<7.	<7.	<6.	<7.	<7.	160	<7.	<7.
Trichloroethene	<20.	<20.	<20.	<19.	<20.	<20.	<20.	<22.	<20.
Vinyl Chloride	<36.	<37.	<36.	<35.	<36.	<37.	<36.	<40.	<37.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	N/A	N/A	N/A	<87	220		<97	
Acenaphthylene					<130	<130		<150	
Anthracene/Phenanthrene					<280	900		<320	
Benzo(a)pyrene					<110	<110		<120	
Benzo(g,h,i)perylene					<200	<200		<220	
Benzo[a]anthracene/Chrysene					<350	<360		<390	
Benzo[b]/(k)fluoranthene					<330	<330		<360	
Dibenz(a,h)anthracene					<170	<180		<190	
Fluoranthene					<110	<110		<120	
Fluorene					<170	340		<190	
Indeno(1,2,3-c,d)pyrene					<200	<200		<220	
Naphthalene					<410	<420		<460	
Pyrene					<150	<160		<170	
Cl-1					<22	<22		<24	
Cl-2					<65	<67		<73	
Cl-3					<65	<67		<73	
Cl-4					<44	220		<48	
Cl-5					<44	1200		<48	
Cl-6					<44	370		<48	
Cl-7					<65	<67		<73	
Cl-8					<65	560		<73	
Cl-10					<110	<110		<120	
Total PCB					ND	2350		ND	

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S3 B08 (06-08)</b>	<b>S3 B08 (10-12)</b>	<b>S3 B08 (12-14)</b>	<b>S3 B09 (06-08)</b>	<b>S3 B09 (10-12)</b>	<b>S3 B10 (06-08)</b>	<b>S3 B10 (10-12)</b>	<b>S3 B11 (06-08)</b>	<b>S3 B11 (10-12)</b>	<b>S3 B12 (05-07)</b>
<b>Volatile Organics</b>										
1,1,1-Trichloroethane	<9.	<9.	<9.	<8.	<9.	<8.	<9.	<9.	<9.	<8.
1,1-Dichloroethane	<7.	<7.	<6.	<6.	<7.	<6.	<7.	<7.	<7.	<6.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	<4.	<3.	<3.	<3.
1,2-Dichloroethane	<15.	<14.	<14.	<13.	<14.	<13.	<15.	<15.	<14.	<14.
Benzene	12	15	3	<3.	<3.	<3.	<4.	<3.	<3.	<3.
Carbon Tetrachloride	<4.	<4.	<4.	<4.	<4.	<4.	<5.	<5.	<4.	<4.
Chlorobenzene	<9.	<9.	<9.	<8.	<9.	<8.	<9.	<9.	<9.	<8.
Chloroform	<9.	<9.	<9.	<8.	<9.	<8.	<9.	<9.	<9.	<8.
cis-1,2-Dichloroethene	830	250	<5.	<5.	<6.	<5.	<6.	<6.	<6.	<5.
Ethylbenzene	460	400	<6.	<6.	<7.	<6.	<7.	<7.	<7.	<6.
m/p-Xylene	860	1600	<17.	<16.	<18.	<17.	<19.	<18.	<18.	<17.
Methylene Chloride	120	78	55	60	54	66	65	71	63	360
o-Xylene	430	350	<3.	<3.	<3.	<3.	<4.	<3.	<3.	<3.
Styrene	<7.	<7.	<6.	<6.	<7.	<6.	<7.	<7.	<7.	<6.
Tetrachloroethene	<7.	<7.	<6.	<6.	<7.	<6.	<7.	<7.	<7.	<6.
Toluene	1400	2400	<11.	<10.	<11.	<10.	<12.	<11.	<11.	<10.
trans-1,2-Dichloroethene	32	19	<6.	<6.	<7.	<6.	<7.	<7.	<7.	<6.
Trichloroethene	<20.	<20.	<19.	<19.	<20.	<19.	<21.	<21.	<20.	<19.
Vinyl Chloride	<37.	<37.	<36.	<34.	<37.	<34.	<39.	<38.	<37.	<34.
<b>Semi-Volatile Organics</b>										
Acenaphthene	<89	N/A		<87	N/A	N/A	N/A	N/A	N/A	N/A
Acenaphthylene	<130			<130						
Anthracene/Phenanthrene	<290			<280						
Benzo(a)pyrene	<110			<110						
Benzo(g,h,i)perylene	<200			<190						
Benzo[a]anthracene/Chrysene	<360			<350						
Benzo[b]/(k)fluoranthene	<330			<320						
Dibenz(a,h)anthracene	<180			<170						
Fluoranthene	<110			<110						
Fluorene	<180			<170						
Indeno(1,2,3-c,d)pyrene	<200			<190						
Naphthalene	<420			<410						
Pyrene	<160			<150						
Cl-1	<22			<22						
Cl-2	<67			<65						
Cl-3	<67			<65						
Cl-4	<45			<43						
Cl-5	<45			<43						
Cl-6	<45			<43						
Cl-7	<67			<65						
Cl-8	<67			<65						
Cl-10	<110			<110						
Total PCB	ND			ND						

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S3 B12 (09-11)</b>	<b>S3 B12 (09-11) FD1</b>	<b>S3 B12 (09-11) FD2</b>	<b>S3 B13 (10-12)</b>	<b>S3 B14 (06-08)</b>	<b>S3 B15 (06-08)</b>	<b>S3 B16 (06-08)</b>	<b>S3 B16-A (09-11)</b>	<b>S3 B17 (06-08)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<9.	<9.	<9.	<9.	<8.	<8.	<8.	<8.	<8.
1,1-Dichloroethane	<7.	<7.	<7.	<7.	<6.	<6.	<6.	<6.	<6.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.
1,2-Dichloroethane	<15.	<15.	<15.	<14.	<14.	<14.	<13.	<14.	<13.
Benzene	<3.	<3.	5	<3.	<3.	5	6	3	<3.
Carbon Tetrachloride	<5.	<5.	<5.	<4.	<4.	<4.	<4.	<4.	<4.
Chlorobenzene	<9.	<9.	<9.	<9.	<8.	<8.	<8.	<8.	<8.
Chloroform	<9.	<9.	<9.	<9.	<8.	<8.	<8.	<8.	<8.
cis-1,2-Dichloroethene	<6.	<6.	<6.	<5.	<5.	<5.	<5.	<5.	<5.
Ethylbenzene	<7.	<7.	<7.	<7.	<6.	<6.	<6.	<6.	<6.
m/p-Xylene	<18.	<18.	<18.	<17.	<17.	<17.	<16.	<17.	<17.
Methylene Chloride	110	100	100	67	66	68	66	65	60
o-Xylene	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.	<3.
Styrene	<7.	<7.	<7.	<7.	<6.	<6.	<6.	<6.	<6.
Tetrachloroethene	<7.	<7.	<7.	<7.	<6.	<6.	<6.	<6.	<6.
Toluene	<11.	<11.	<11.	<11.	<11.	<10.	<10.	<10.	<10.
trans-1,2-Dichloroethene	<7.	<7.	<7.	<7.	<6.	<6.	<6.	<6.	<6.
Trichloroethene	<21.	<21.	<21.	<20.	<19.	<19.	<18.	<19.	<19.
Vinyl Chloride	<38.	<38.	<38.	<36.	<35.	<34.	<34.	<35.	<34.
<b>Semi-Volatile Organics</b>									
Acenaphthene	<92	<89		N/A	N/A	N/A	N/A	N/A	N/A
Acenaphthylene	<140	<130							
Anthracene/Phenanthrene	<300	<290							
Benzo(a)pyrene	<110	<110							
Benzo(g,h,i)perylene	<210	<200							
Benzo[a]anthracene/Chrysene	<370	<360							
Benzo[b]/(k)fluoranthene	<340	<340							
Dibenz(a,h)anthracene	<180	<180							
Fluoranthene	<110	<110							
Fluorene	<180	<180							
Indeno(1,2,3-c,d)pyrene	<210	<200							
Naphthalene	<440	<420							
Pyrene	<160	<160							
Cl-1	<23	<22							
Cl-2	<69	<67							
Cl-3	<69	<67							
Cl-4	<46	<45							
Cl-5	<46	<45							
Cl-6	<46	<45							
Cl-7	<69	<67							
Cl-8	<69	<67							
Cl-10	<110	<110							
Total PCB	ND	ND							

All measurements in ppb / dry weight

**Organic Compound Analysis for the Hanscom Air Force Base ETI Project**

<b>Sample ID</b>	<b>S3 B18 (06-08)</b>	<b>S3 B19 (09-11)</b>	<b>S3 B20 (10-12)</b>	<b>S3 B21 (13.5-15)</b>	<b>S3 B22 (10-12)</b>	<b>S3 B23 (08-10)</b>	<b>S3 B23 (13-15)</b>	<b>S3 B23 (16-18)</b>	<b>S3 B24 (9.5-11)</b>
<b>Volatile Organics</b>									
1,1,1-Trichloroethane	<8.	<8.	<8.	<8.	<8.	<8.	<8.	<9.	<8.
1,1-Dichloroethane	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<7.	<6.
1,1-Dichloroethene	<3.	<3.	<3.	<3.	<3.	<3.	15	<3.	<3.
1,2-Dichloroethane	<13.	<13.	<13.	<14.	<14.	<14.	<14.	<15.	<14.
Benzene	<3.	<3.	5	<3.	7	<3.	4	<3.	6
Carbon Tetrachloride	<4.	<4.	<4.	<4.	<4.	<4.	6	<5.	<4.
Chlorobenzene	<8.	<8.	<8.	<8.	<8.	<8.	<8.	<9.	<8.
Chloroform	<8.	<8.	<8.	<8.	<8.	<8.	<8.	<9.	<8.
cis-1,2-Dichloroethene	<5.	<5.	<5.	<5.	<5.	<5.	<5.	<6.	<5.
Ethylbenzene	<6.	<6.	<6.	<6.	<6.	<6.	7	<7.	<6.
m/p-Xylene	<16.	<16.	<17.	<17.	<17.	<17.	<17.	<18.	<17.
Methylene Chloride	64	63	59	70	63	63	81	68	73
o-Xylene	<3.	<3.	<3.	<3.	<3.	<3.	17	<3.	<3.
Styrene	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<7.	<6.
Tetrachloroethene	<6.	<6.	<6.	<6.	<6.	<6.	23	<7.	<6.
Toluene	<10.	<10.	<10.	<11.	<10.	<11.	<10.	<11.	<11.
trans-1,2-Dichloroethene	<6.	<6.	<6.	<6.	<6.	<6.	<6.	<7.	<6.
Trichloroethene	<19.	<18.	<19.	<19.	<19.	<19.	<19.	<21.	<19.
Vinyl Chloride	<34.	<34.	<34.	<35.	<34.	<35.	<34.	<38.	<35.
<b>Semi-Volatile Organics</b>									
Acenaphthene	N/A	N/A	N/A	N/A	N/A	<85			
Acenaphthylene						<130			
Anthracene/Phenanthrene						<280			
Benzo(a)pyrene						<110			
Benzo(g,h,i)perylene						<190			
Benzo[a]anthracene/Chrysene						<340			
Benzo[b]/(k)fluoranthene						<320			
Dibenz(a,h)anthracene						<170			
Fluoranthene						<110			
Fluorene						<170			
Indeno(1,2,3-c,d)pyrene						<190			
Naphthalene						<400			
Pyrene						<150			
Cl-1						<21			
Cl-2						<64			
Cl-3						<64			
Cl-4						<42			
Cl-5						<42			
Cl-6						<42			
Cl-7						<64			
Cl-8						<64			
Cl-10						<110			
Total PCB						ND			

All measurements in ppb / dry weight

Metals Analysis by Field Inductively Coupled Plasma/Optical Emission Spectroscopy

	Field ICAP		Field ICAP Dry		
	Wet Value		Value		
	% Solids	Pb	Cd	Pb	Cd
S1-B10-(6-8)	90.4	6.3	nd	7.0	nd
S1-B11-(2-4)	93.4	11	0.40	11	0.43
S1-B11-(5-6)	93.4	18	0.45	19	0.48
S1-B11-(8-9.5)	81.1	8.9	0.43	11	0.53
S1-B12A-(2-4)	93.7	7.3	0.53	7.8	0.57
S1-B12A-(5-6.5)	93.7	10	0.36	11	0.38
S1-B13-(2-4)	91.0	7.5	nd	8.2	nd
S1-B17A-(10-12)	93.1	7.2	nd	7.8	nd
S1-B17A-(2-4)	84.2	28	0.33	34	0.39
S1-B17A-(5.75-8)	92.3	34	0.41	37	0.44
S1-B1A-(12-14)	92.3	nd	nd	nd	nd
S1-B1A-(2-4)	95.5	21	nd	21	nd
S1-B1A-(2-4) FD	94.4	22	0.39	23	0.41
S1-B1A-(6-8)	90.0	nd	nd	nd	nd
S1-B1A-(9-11)	89.6	7.3	nd	8.2	nd
S1-B2-(2-4)	95.5	12	0.42	12	0.44
S1-B2-(6-8)	91.6	8.1	0.40	8.8	0.44
S1-B3-(2-4)	92.9	19	0.42	20	0.45
S1-B3-(6-8)	92.5	9.5	0.66	10	0.71
S1-B4-(2-4)	83.5	14	nd	17	nd
S1-B4-(6.2-8)	71.6	16	nd	22	nd
S1-B4-(9.5-12)	81.6	13	nd	16	nd

	Field ICAP Wet Value		Field ICAP Dry Value		
	% Solids	Pb	Cd	Pb	Cd
		mg/kg	mg/kg	mg/kg	mg/kg
S2-B1-(12-14)	93.9	243	nd	259	nd
S2-B1-(16-18)	93.4	181	0.33	194	0.35
S2-B1-(20-22)	86.8	12	0.38	14	0.44
S2-B1-(9-11)	90.5	19	nd	21	nd
S2-B10-(10-12)	92.1	7.2	nd	7.8	nd
S2-B10-(6-8)	94.4	7.2	nd	7.6	nd
S2-B11-(12-14)	93.5	8.1	0.36	8.7	0.38
S2-B11-(14-16)	92.6	5.0	nd	5.4	nd
S2-B11-(16-18)	82.2	nd	nd	nd	nd
S2-B11-(8-10)	92.7	8.7	nd	9.4	nd
S2-B12-(12-14)	91.6	10	0.37	11	0.40
S2-B12-(18-20)	88.1	6.4	nd	7.3	nd
S2-B12-(18-20)FD	84.2	5.4	nd	6.4	nd
S2-B12-(9-11)	93.6	14	nd	15	nd
S2-B13-(14-16)	94.0	25	nd	26	nd
S2-B13-(18-20)	89.4	7.6	nd	8.5	nd
S2-B13-(8-10)	93.4	13	nd	14	nd
S2-B14-(12-14)	93.0	11	0.35	12	0.38
S2-B14-(18-20)	84.8	6.5	nd	7.6	nd
S2-B14-(8-10)	92.1	13	0.36	14	0.39
S2-B15-(10-12)	91.9	12	nd	13	nd
S2-B15-(14-16)	90.5	327	5.7	362	6.29
S2-B15A-(10-12)	92.9	13	nd	14	nd
S2-B15A-(14-16)	93.6	13	nd	14	nd
S2-B15A-(18-20)	84.4	nd	nd	nd	nd
S2-B2-(10-12)	90.0	107	nd	119	nd
S2-B2-(13-15)	91.0	94	nd	103	nd
S2-B2-(16-18)	90.5	60	0.55	67	0.60
S2-B2-(20-22)	85.7	14	nd	16	nd
S2-B2-(20-22) FD	83.9	18	0.36	21	0.43
S2-B3-(10-12)	92.0	38	nd	42	nd
S2-B3-(13-15)	94.4	106	nd	112	nd
S2-B3-(16-18)		70	0.38		
S2-B3-(18-20)	85.0	9.4	0.93	11	1.09
S2-B4-(10-12)	90.9	18	nd	20	nd
S2-B4-(13-15)	93.5	204	0.49	218	0.52
S2-B4-(16-18)	88.9	58	nd	65	nd
S2-B4-(19-21)	85.0	16	nd	19	nd

	Field ICAP		Field ICAP Dry		
	Wet Value		Value		
	% Solids	Pb	Cd	Pb	Cd
S2-B5-(10-12)	86.3	5.6	nd	6.5	nd
S2-B5-(2-4)	96.5	13	nd	13	nd
S2-B5-(6-8)	88.9	nd	nd	nd	nd
S2-B5-(8-10)	90.2	9.6	nd	11	nd
S2-B6-(10-12)	87.9	6.5	nd	7.4	nd
S2-B6-(2-4)	92.5	42	0.33	46	0.36
S2-B6-(6-8)	94.2	nd	nd	nd	nd
S2-B7-(2-4)	94.0	5.2	nd	5.5	nd
S2-B7-(5-7)	94.1	5.9	nd	6.3	nd
S2-B7-(8-10)	93.9	8.6	nd	9.2	nd
S2-B8-(12-14)	95.5	7.2	nd	7.5	nd
S2-B8-(15-17)	88.8	nd	nd	nd	nd
S2-B8-(18-20)	86.9	6.9	nd	7.9	nd
S2-B8-(8-10)	92.9	21	0.37	23	0.40
S2-B9-(10-12)	92.5	5.5	nd	5.9	nd
S2-B9-(6-8)	94.2	7.7	nd	8.1	nd

	Field ICAP Wet Value		Field ICAP Dry Value	
	% Solids	Pb	Cd	Pb
		mg/kg	mg/kg	mg/kg
S3-B1-(10-12)	89.5	34	11	38
S3-B1-(13-15)	93.2	61	5.2	65
S3-B1-(17-19)	90.4	52	1.1	57
S3-B10-(10-12)	85.6	5.8	nd	6.8
S3-B10-(6-8)	96.9	5.1	nd	5.2
S3-B11-(10-12)	90.1	6.5	nd	7.2
S3-B11-(6-8)	85.9	6.3	nd	7.4
S3-B12-(5-7)	96.2	7.4	0.49	7.6
S3-B12-(9-11)	87.1	nd	0.37	nd
S3-B12-(9-11) FD	89.5	5.3	0.44	6.0
S3-B13-(10-12)	91.7	5.9	nd	6.4
S3-B14-(6-8)	94.8	5.0	nd	5.3
S3-B15-(6-8)	96.1	5.4	nd	5.7
S3-B16-(6-8)	97.7	nd	nd	nd
S3-B16A-(9-11)	95.3	6.2	0.41	6.5
S3-B17-(6-8)	96.7	nd	nd	nd
S3-B18-(6-8)	97.0	5.6	nd	5.7
S3-B19-(9-11)	97.8	nd	nd	nd
S3-B2-(10-12)	92.8	20	1.7	21
S3-B2-(12-14)	94.2	12	0.85	13
S3-B2-(12-14) FD	95.1	13	0.71	14
S3-B2-(17-19)	88.1	5.9	0.35	6.7
S3-B20-(10-12)	96.4	7.6	nd	7.9
S3-B21-(13.5-15)	94.4	7.2	nd	7.6
S3-B22-(10-12)	96.0	nd	nd	nd
S3-B23-(13-15)	96.1	8.6	0.35	8.9
S3-B23-(16-18)	87.3	nd	nd	nd
S3-B23-(8-10)	94.3	11	0.84	11
S3-B24-(9.5-11)	94.4	7.0	0.59	7.4
S3-B3-(10-12)	91.8	34	10	37
S3-B3-(2-4)	90.6	8.3	nd	9.1
S3-B3-(6-8)	95.3	8.0	0.56	8.4
S3-B4-(10-12)	92.2	27	21	29
S3-B4-(12.5-14)	89.0	20	14	22
S3-B5-(10-12)	91.7	39	33	43
S3-B5-(14-16)	93.3	38	25	41
S3-B5-(17-19)	91.8	5.5	0.91	6.0
S3-B6-(10-12)	90.0	17	0.56	19.3

	Field ICAP		Field ICAP Dry		
	Wet Value		Value		
	% Solids	Pb	Cd	Pb	Cd
S3-B6-(16-18)	82.5	5.4	nd	6.5	nd
S3-B7-(10-12)	90.4	28	0.43	31	0.48
S3-B8-(10-12)	89.7	13	nd	15	nd
S3-B8-(12-14)	92.4	7.0	nd	7.6	nd
S3-B8-(6-8)	89.6	24	0.40	27	0.45
S3-B9-(10-12)	89.9	nd	nd	nd	nd
S3-B9-(6-8)	97.1	5.5	nd	5.7	nd

## Summary of Lead and Cadmium Values by Energy Dispersive X-ray Fluorescence

**Tufts University Laboratory**

#	Sample ID	Pb*	Cd*
		(mg/kg)	(mg/kg)
1	S1-B11-(5-6)	29.7	ND
2	S1-B17-2(10-12)	22.7	ND
3	S1-B18-(5-7)	51.8	ND
4	S2-B1-(9-11)	29.5	ND
5	S2-B1-(12-14)	226	ND
6	S2-B1-(16-18)	121	ND
7	S2-B2-(20-22)	23.7	ND
8	S2-B3-(10-12)	66.5	2.4
9	S2-B3-(18-20)	19.2	4.5
10	S2-B4-(10-12)	38.9	ND
11	S2-B4-(16-18)	82.3	ND
12	S2-B5-(2-4)	31.1	ND
13	S2-B6-(2-4)	53.0	ND
14	S2-B7-(8-10)	23.1	ND
15	S2-B8-(8-10)	45.3	ND
16	S2-B10-(10-12)	14.4	ND
17	S2-B11-(16-18)	16.7	3.1
18	S2-B12-(12-14)	19.5	3.7
19	S2-B13-(14-16)	28.1	ND
20	S2-B15-(14-16)	418	14.9
21	S2-B15A-(10-12)	24.3	ND

#	Sample ID	Pb*	Cd*
		(mg/kg)	(mg/kg)
22	S3-B1-(10-12)	46.8	43.5
23	S3-B1-(13-15)	63.4	12.5
24	S3-B1-(17-19)	51.1	2.4
25	S3-B2-(10-12)	25.1	ND
26	S3-B2-(12-14)	24.0	ND
27	S3-B2-(12-14) FD	26.6	2.9
28	S3-B2-(17-19)	18.1	ND
29	S3-B3-(6-8)	24.1	ND
30	S3-B3-(10-12)	44.8	30.1
31	S3-B4-(10-12)	33.7	53.8
32	S3-B4-(12.5-14)	27.1	40.0
33	S3-B5-(10-12)	63.1	137
34	S3-B5-(14-16)	50.2	70.4
35	S3-B5-(17-19)	17.3	ND
36	S3-B6-(10-12)	28.6	ND
37	S3-B6-(16-18)	23.6	3.4
38	S3-B7-(10-12)	40.9	2.4
39	S3-B8-(10-12)	23.6	ND
40	S3-B8-(12-14)	14.4	ND
41	S3-B8-(6-8)	45.3	ND
42	S3-B9-(6-8)	20.4	5.5
43	S3-B9-(10-12)	21.3	7.5
44	S3-B10-(6-8)	19.6	ND
45	S3-B10-(10-12)	17.5	5.0
46	S3-B11-(6-8)	19.1	3.6
47	S3-B11-(10-12)	21.0	ND
48	S3-B12-(5-7)	21.8	ND
49	S3-B12-(9-11)	24.0	ND
50	S3-B12-(9-11)FD	18.1	ND
51	S3-B13-(10-12)	19.1	ND
52	S3-B14-(6-8)	21.8	ND
53	S3-B15-(6-8)	17.0	ND
54	S3-B16-(6-8)	17.2	2.1
55	S3-B16A-(9-11)	16.8	ND
56	S3-B17-(6-8)	15.8	ND
57	S3-B18-(6-8)	15.2	ND
58	S3-B19-(9-11)	20.2	ND
59	S3-B20-(10-12)	24.2	ND
60	S3-B21-(13.5-15)	16.6	ND
61	S3-B22-(10-12)	16.0	ND
62	S3-B23-(8-10)	14.5	ND
63	S3-B23-(13-15)	18.6	ND
64	S3-B23-(16-18)	11.7	2.4
65	S3-B24-(9.5-11)	17.2	4.0
Detection Limit		7.8	1.8

\*Livetime : 200 sec (n = 1)